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A REVISION OF THE PRONOUNS.

WITH SPECIAL EXAMINATION OF RELATIVES AND RELATIVE CLAUSES.*

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CHAPTER I.—GENERAL SURVEY.

THE PRONOMINAL MEDLEY.

With a stone that sparkles, an Indian arrow-head, a spitted dragon-fly, the farm-lad begins a "collection of curiosities," which grows in bulk only to grow also more incongruous. With hardly more definite purpose Grammar has selected the members of the pronominal word-class. Amused by here and there a verbal oddity, the pseudo-science also may be said to have formed a collection of linguistic curiosities; and these in disparity match the objects assembled by boyish caprice.

Into this aggregation are entered "some," which stands at times for any persons whatever, and "I," which is perhaps the most exclusive element of speech. "Who" (relative), although it requires an antecedent, is fraternized with "this" and "that," which do not. Words said to ask a question are grouped with others used to answer questions. In this field the lion and the lamb lie down of a truth together.

Indiscriminable admission is offset by undeserved omission, partly inadvertent, it would seem, and partly arbitrary. It usually is not seen that "few" and "many," being quite as truly

*A dissertation for which the degree of Doctor of Philosophy was awarded by Yale University. A selection from Chapter III. of this article was read before the American Philological Association, at the meeting of July, 1900.

indefinite as "some," may quite as justly claim the rank of indefinite pronouns. Again it must be seen that "here" and "there" are fully as demonstrative as "this" and "that;" but pronominal rank is withheld from "here" and "there," because they are not also substantive. That is, the pronominal group, already irrational because both incongruous and incomplete, is further irrationalized to fit it for a place in the larger absurdity known as the Parts of Speech.

In forming these it has caught the notice of Grammar that this or that word is always used to name the same thought-element;[1] and no doubt a language might be so constructed that every word, whenever used, would thus express a particular element of thought. As a matter, however, of fact, such regularity is not obtained by any language.[2] To attempt then a classification of words by what may be called the function of their ideas is hardly more encouraging than to venture a classification of the fowls by their position in the barn-yard.

The unavailability of function as a basis for classification is, however, no derogation to its importance. The understanding of speech consists, it is true, on the one hand most obviously in obtaining right ideas, but not less truly, on the other hand, in rightly putting them together. Correct perception of function, then, is indispensable. Its emphasis, even in a misguided effort, might therefore have been helpful, were it not that function, in the differentiation of the parts of speech, has been hopelessly confounded with other matters. Thus, the adverb being defined by *function* as an adjunct (of various sorts), the adjective is, by an altogether different criterion, distinguished as a word with a qualitative *meaning*. Still another ground of distinction is found in what a word is said *to do*, the conjunction being defined as "a word which joins." It might be also proven that

[1] Thus "exceeds" will never be used to name a first term (point of thought-departure, subject), or a last term (point of thought-arrival, object, predicate); it will always name a relation, an impression derived from a pair of ideas; that is, it will be used as a mid-term.

[2] Thus of a spliced rope it may be said that "The *overlap* of the two parts is three feet;" or "The two parts have an *overlap* of three feet;" or "The strands of one part *overlap* those of the other." That is, in these examples the word "overlap" names an idea successively used as subject, object and mid-term, being twice therefore a noun and once a verb. It may also even be said that "The *overlap* factor is ten per cent.," the same word being in this case made to functionate as adjective.

words are further sometimes differentiated by *association,* that is, by the company which they keep.[1] To classify by criteria so shifting is hardly more rational than to divide the animal kingdom into carnivora, aquatics, vertebrates, and plantigrades; say flesh-eaters, water-dwellers, back-boned and flat-steppers. The candidates for pronominal rank are, however, obliged to run the gauntlet of this classification, those only being accepted as pronouns which reach the substantive line.

In further grammatical treatment these substantive survivors are subjected to further violence, being forced into sub-classes painfully distinguished as personal, demonstrative, reflexive, indefinite, relative and interrogative. The distinctions indicated by these group-names are, however, plainly inadequate. For instance, the indefinite "some," as in "Some say," is also distinctly personal; while on the other hand the personal "they," without an antecedent, as in "They say that France will fight," is also distinctly indefinite. "Who," again, is regularly personal, whether relative or interrogative.

Such procedure is the more surprising in view of the wisdom shown in choosing a point of departure, the characteristic, that is, put forward as distinctively pronominal. A hint of this characteristic is offered in the pronoun's name and definition. By the word "*pro*nomen" it is immediately suggested that something is conceived as *for* something. Now, if what be meant is a something "pro nomine," or "for a word," that something is obviously itself a word; for no other kind of substitute is under consideration. So also if what be meant is a "nomen pro," or "a word for something," this something must either be a word or an idea, since only ideas and words are under consideration. But an idea is not intended; for to stand "pro" or "for" an idea is the usual office of words, and no peculiarity of the pronoun. Whichever, then, be the syntax hidden in "pronomen," the meaning is "a word for another word."[2]

[1] Thus in (1) "The flag is red" and (2) "Scarlet resembles red" the ideas named by "red" (1) and "red" (2) are the same, being distinguishable only by the different relations in which they stand to "flag" and "scarlet," respectively. "Is" means, in this case, the relation of an object to its own quality, thereby obtaining for "red" (1) the rank of an adjective. "Resembles" names another relation, thereby losing for "red" (2) the adjective rank.

[2] That "nomen" is actually used by Grammar in the more restricted meaning of "noun" is ground of objection on p. 28.

This interpretation is confirmed by abundant definitions and descriptions which agree in this, that the pronoun is a sort of proxy, and not a linguistic principal; in other words, it presents ideas by an indirect or mediate process. To illustrate, using for convenience the conversational forms, suppose you enter my room as I utter the words "He is going to Europe."[1] It is plain that you will not know of whom I am thinking. But had you come in a moment sooner, you would have heard an ampler statement, namely, "Brown says he is going to Europe." In this form of my example you know without a doubt of whom I am thinking, and that I think of him twice, once as saying, and once as going. My first thinking is indicated by the word "Brown," my second, by the word "he." But the powers of these words are very different. The symbol "Brown" reveals the subject of my thought without recourse to the aid of any other word. The symbol "he" can not, on the other hand, express my meaning except as a proxy, taking the place of "Brown," its linguistic principal.

That the exploitation of this distinction has been attended by extreme confusion is perhaps sufficiently shown by illustrations already offered. That the distinction itself is eminently just and will rationally differentiate the pronouns I shall endeavor to show in the following section. Meantime this distinction may be used to aid the further appreciation of Grammar's extraordinary achievement, of which I offer the following objective illustration: Having on my farm a considerable number of animals, I find it convenient to classify them by structural differences. I thus obtain two classes, the equine and the bovine. The latter, as it happens is somewhat numerous, while of the former there are very few. Indeed this obvious difference in number, and therefore in commonness, rather supplants in my attention the structural difference first utilized. The horses come to impress me most conspicuously as exceptions. Of my cows, too, the most indeed are Jerseys; a few, however, are black, that is again, exceptions. So I fall into the habit of grouping the black cows with the horses in what I cannot properly now distinguish as anything but an exceptional class. But the nucleus of this class was, after all, the horses, originally known as the equine class. Noting merely that this nucleus has been augmented, but overlooking the change of criterion which allowed the augmentation, I continue the use of the title equine with a class which now contains not only horses but also cows. Developing the possibili-

[1] I bar the occasional use of "he" to name the person par excellence of common acquaintance. This usage will be examined under another head.

ties latent in systematic zoology of this sort, I arrive at ultimate groups as follows: first, the equine, containing the horses, the black cows, the spotted calf, the bull, and the cow with the crumpled horn; second, the bovine, containing other cows and calves.

The procedure of Grammar is quite analogous, though carried further, developing first a proxy class, correct, but never adequately understood. The vast remainder, the linguistic principals, have hardly been more than subconsciously recognized as such. The words of the proxy class, or pronouns proper, being few in number, readily come to be dominantly regarded as exceptional. Whether under this aspect or some other,[1] they do as a matter of fact, admit to fellowship the also exceptional personals, demonstratives, indefinites and interrogatives, the work of primary differentiation being so far undone. For as will be amply shown, the personals, demonstratives, etc., so far as merely such, are not proxies but principals.[2]

Grammatical classification may, at this stage, be indicated by the following diagram, the members of the now no longer exclusively proxy class (as conceived by Grammar), being put in italics or in capitals.

Words						
True Proxies		True Principals				
	Pers.	Dem.	Indef.			
HE, SHE, etc.	I	THIS	SOME	Addition,	life, death,	etc. = Noun
				Add,	live, die,	etc. = Verb
His (= suus)	*Our*	*Hiesig*	*Quelque*	Additional,	live, dead,	etc. = Adj.
	Uswards	*Hier*	*Somewhere*	Additionally,		etc. = Adv.
		Hence (thought connective)		And,		etc. = Conj.

The proposition of Grammar, then, is simply this: all words are of two classes; those which do and those which do not require aid; yet those which do, include a superior number of those which do not. By cross classification the remainder of those which do not require aid (e. g., the words in Roman type) are subdivided into nouns, verbs, etc.

Peter, having been robbed to enrich Paul, is now in part indemnified; the pronominal class of proxies, previously extended to include personals, etc., is now heavily reduced by the distribution of all but its substantive members among the adjectives, etc., of the principals. That is, the proxies having taken in many principals, the principals in turn absorb the bulk of the proxies. At this stage Grammatical procedure leaves only the capitalized words of the above diagram in the proxy class, now no longer such either exclusively or exhaustively.

[1] The appendixes further show that personals, demonstratives, and indefinites have also, at times, a vicarious value.

[2] In the meantime observe that in "*Some* say," "*I* am glad to see *you*," "*This* is my brother," "*Who* is there?", the italicised words perform their duties fully without the aid of other words, that is, as principals.

The final act in the farce is the recognition of the remaining, the substantive proxies, as a new part of speech. To diagram this result, the capitalized words of the diagram should be entered among the principals, say under the word "addition," abreast of the new title "pronouns." In other words, of the primary classes one is coördinated with the sub-classes of the other. Thus is completed a system already accused in a general way of capricious selection, careless omission, arbitrary rejection, inadequate sub-division—a system now specifically charged with repeated and bare-faced violation of its prime criterion—a system which may in a sense be known as Grammar's second Babel or "confusion of tongues."

In view of what has thus far been brought to light, it is hardly too much to assume that to an orderly mind the grammatical conception of the pronouns is untenable. But an effort to mend this conception can hardly be cheered by the hope that its results, even if good, will generally be preferred. He who likes the European oyster is rarely brought to like the American. It is not to be expected that the votaries of Grammar will welcome any substitute for what it offers.

It must be admitted, too, that in the very nature of the case, the linguistic method of one mind can hardly be proven to be that of others; for as one door gives exit both to the great and the little cat, so also, and notoriously, a given set of words may be used by different minds to open passage for thoughts conspicuously different. Thus to me the phrase "if you please" is synonymous with "if you like (or prefer)," "you" being my subject, and "please" having a meaning very different from what appears in "This pleases me." This opinion I defend by the sister phrases "If I please, he pleases, we please, etc." But to a grammarian oblivious of these, saturated with syntax genealogy, intensely conscious for instance of "si tibi placet," I doubt not that, as is often claimed, my illustration has the meaning, "if to you be pleasing." Speaking for himself alone, no doubt the grammarian is right. Speaking only for myself, I believe that I also am right. Without attempting to determine which interpretation is better or more common, I merely emphasize the fact that what is linguistically true of one mind may be quite untrue of another. Believing thus, I must, in much of what follows, be understood as offering a merely personal contingent to the little total of our present observation; as describing the thought-forms of my own mind, without claiming that those of other minds must always be the same; as appreciating that the views to be advanced can acquire authority only so far as shared by many and able thinkers.

The presentation of these views is further attended by this practical difficulty, that the same linguistic means are employed, even by the same persons, now for one and now for another linguistic end. Thus "who" is used on one occasion as a relative, on another as an inter-

rogative, and in some languages even still otherwise, meaning "one" or the "other," "this one" or "that one." More objectively, the jack-knife serves its owner in turn as gimlet, hammer and tooth-pick. Such activities I can easily *differentiate;* but I can not so easily express my results. Language is not lavish of names for groups of distinctive characteristics, especially those of the accidental or ephemeral order. For the total of distinctives, whereby a knife is ranked for the moment as a hammer, I need such a word as "hammerness;" but it does not exist. Also, even if I had such words, they would be very ineffective, an argument upon abstractions being notably hard to follow. Finding it thus impracticable to discuss the different characteristics of words, I must make my discussion, in form at least, one of words differently characterized. This involves me at once in a formal contradiction. My jack-knife is ranked as a gimlet, a hammer and a tooth-pick. The word "who" is classed as a demonstrative, a relative, and an interrogative. I may indeed laboriously stipulate that neither knife nor word is in three classes at the same time. Or I may resort to the clumsy expedient of calling "who" three different words, or my knife three different objects. But neither course is satisfactory. The best I can do, to avoid wrong understanding on the one hand and no understanding on the other, is to say that, while for convenience I shall seem to classify words, I shall really be aiming to differentiate their functions, their meanings and their methods of meaning-presentation.

REDIFFERENTIATION.

In the effort to bring order into the confusion wrought by Grammar, I invite increased attention to the fundamental distinction between proxy and principal, reviving the illustration "Brown says he is going to Europe." As I utter the word "Brown," it suggests to you an idea essentially the same as my own, and this without the aid of any other word, being, it may be argued, self-explanatory. The same is true of every element of my sentence except the element "he," which can not suggest my idea except for explanatory aid, afforded in the present case by "Brown."

This simple distinction, of the highest value in word-study, though strongly emphasized by Grammar, has been curiously misapplied. Words of the "he" class have been isolated from others on the ground that they revive an idea already suggested by another word or, in grammatical parlance, " refer to an antecedent." But such revival confers no distinction, being effected

by multitudes of other words. Thus, suppose I say "Brown saw Mr. McKinley today. The president is looking well." Like the word "he" the word "president" revives an idea suggested by a preceding word, doing all, in short, that can be done by "he," and merely doing it better. It is therefore not in what the word "he" *can* do, but in what it can *not* do, not in its powers but in its limitations, that we must find the ground for isolating it from others. And what it can *not* do, as previously shown, is to suggest without aid an intended idea.

The difference then between other words and words like "he" is roughly that of candle and mirror. The one emits a light of its own; the other is a mere reflector. Such a difference may safely be used as primary; for it is absolute and fundamental. It is also psychologically initial. The process by which I call up in your mind an idea is necessarily prior in time to its appearance in your mental field. Before you can cook or even *have* your hare, you must catch it. In comparison, then, to the question how an idea is obtained, all other questions are actually subsequent and may plausibly rank as subsidiary; by these I mean the questions of the idea's nature, of its use in thought-structure (function), of its sentential neighbors (association), of what in grammatical parlance it is said "to do"—the tests, in short, which Grammar has applied in distinguishing the other parts of speech and the pronominal subdivisions.

Seeking now to prepare the way for a suitable terminology, I slightly change my previous form of statement. In the example "Brown says he is going to Europe," I prefer to put it that "Brown" is able to take the initiative in the complete suggestion of an idea. Self-sufficient words of this order may therefore be known as *initiatives.*

The word "he," on the other hand, is unable to perform the initiative act. When, however, this act has once been performed by "Brown," the hearer, looking mentally backward to the idea suggested by "Brown," can use it as the meaning of "he." Indeed, the use of "he" is a virtual order to the hearer thus to look backward, to find a previously used idea, and to use that idea again as part of a present thought. Words of this type may be known as *retrospectives.*

It would be natural to suppose that the self-sufficient meaning-namer must always thus stand first in the sentence, and that the word which needs its help should defer appearance until that help is present, and therefore available. Such, however, is not always the case. Thus, "Though he is very busy, Brown is going to Europe." In this example you can not know who is meant by "he" until you reach the later "Brown." It might seem that in this case "he" should be called initiative, and "Brown" retrospective. And so indeed they should, were mere order the criterion. But the actual criterion is the power to present in full an intended meaning, or, otherwise phrased, ability to take the initiative in idea-naming. Now the word "he" may seem to make an effort in this direction. But even if it does, it scores no success; and therefore it cannot justly be called initiative. As a matter of fact, however, "he" makes no such effort. For surely you do not credit me with trying to show you whom I mean by the aid of so helpless a word as "he." And I am very certain that I do not so intend the word myself. Judged then, by my intention, by your acquiescence, and by results, the word "he" can not be called initiative.

Its actual use is as follows: it expresses very inadequately, in a purely provisional way, an idea which I intend to express with more exactness by a later word. In fact, the use of "he" in this case is a virtual order to you to look forward mentally to an idea yet to be distinctly presented. As such you accept the "he" and, tolerating its momentary inadequacy, you do look forward in mind to the adequate idea which it vaguely prefigures. Judged then by my intention, by your acquiescence, and by results accomplished, words employed thus may be known as anticipative or *prospective.*

The prospective and retrospective words are characterized alike by incompetency, except so far as aided by the self-sufficient initiatives. They may therefore be grouped together under the common title of insufficient or *vicarious.* The prime divisions then of words, based upon their method of presenting meaning, are the initiatives and the vicarious, the latter being subclassed as prospective and retrospective.

Initiatives compose the main body of every vocabulary, the

signs of what I mean outnumbering, as might be expected, the signs of what I have meant or what I am about to mean. The forward and backward looking words are indeed but prologue and epilogue of the sentential drama. Few in number and unique in tactics, they form a sharply isolated class to which our special attention will be given. In the meantime I wish, for the sake of the side-lights offered, to pass in review the other so-called pronominal groups, which Grammar has established by the aid of further characteristics, more or less distinctly apprehended. As, however, any effort spent upon them is in my own opinion a digression, it is consistent and helpful to the clearness of exposition to designate them as *pseudopronouns*, recognizing the vicarious words alone as strictly pronominal.

Among the different characteristics which Grammar has utilized in establishing the pseudopronominal groups, I elect, as most convenient to start with, indefiniteness in the meaning expressed. The effort to separate the definite and the indefinite is not, to be sure, especially hopeful. But, assuming that it can be successfully accomplished, I subdivide the initiatives into *definites* and *indefinites.*[1]

The definites are subject to further differentiation, according as the ideas which they exhibit do or do not change with change in the speaker. The difference between them appears most clearly in spatial relations. Suppose for instance that you and I are facing each other, you looking southward. Directly between us stands a tree, and a little to one side a bush. Of this bush I remark, "It is east of the tree". The relation between bush and tree is quite definite; it is correctly expressed by the word "east"; and the expression perfectly fits my personal point of view. Moreover, if you wish yourself to express this relation, you may also say with perfect truth, "The bush is east of the tree". That is, the word "east" fits your point of view no less exactly than it does my own. This is but saying that neither of us, in using the idea expressed by "east," puts into it any element peculiar to himself. Self, indeed, so far as may be,

[1] The same subdivision may be effected with the vicarious words; but as it is unnecessary and not suggested by Grammar, it is not attempted. For the same reason other possible subdivisions invited later are not carried out.

is eliminated. East is in my conception "east", no matter who I am or where I am or how I face or what may be the status of any other person. The idea, as far as it can be, is objective and absolute. The points of compass could hardly change, were the race removed to another planet. Such ideas assume, it is true, and must assume, a standard of comparison; and this standard no doubt is recognized by man alone; but the standard is not man himself, the species or the individual; and it is not a secondary standard, reckoned from man as a primary. Be it the North Star or the sun or the path of the sun across the sky; be it the meridian of Greenwich, as for longitude; or be it an origin of co-ordinates, as in analytic geometry; in ideas of the present class the standard is never self.

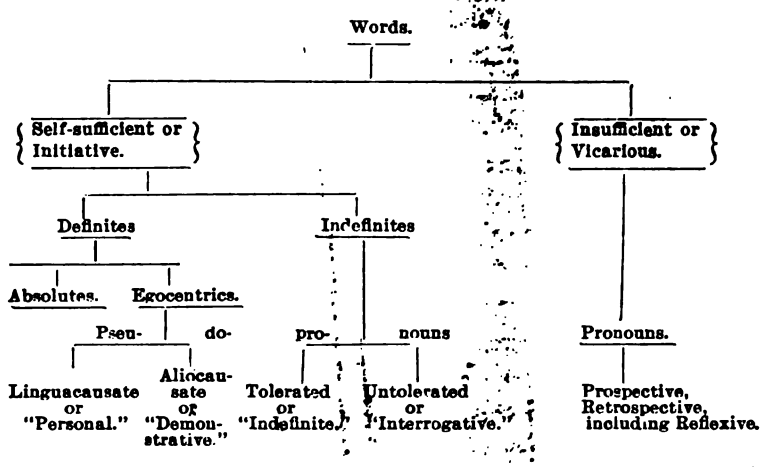
With numerous other words the standard is always self. Given again the objects of my last illustration, I may elect to say, "The bush is on the right of the tree". With the same relation of bush and tree in your mind as in my own, suppose that you yourself now wish to make a statement equivalent to mine; you will say, "The bush is on the left of the tree". Our difference in statement of the same actual relation indicates that we conceive the relation differently. In other words, the relational idea changes with the change in the relation-thinker. This covariance is occasioned by the fact that something of the thinker's self enters or affects the relation. The categories "right" and "left" are not obtained, like "east" and "west," from the external universe; they are obtained directly from the material self. Were my body symmetrical in all directions, or were I a disembodied spirit of the conventional type, it is difficult to imagine how such ideas could arise. Constituted even as I am, these ideas vary with the changes of my position. They may be valid not only for self alone, but for the self only of the moment. Hence their passage from my usage to your own involves some taking out of my personality and some putting in of yours. Their peculiarity may be indicated by saying that they are *egocentric*. That is, the individual self affects the nature of the idea. Self is the point of departure, the center from which the mental outreach proceeds.

Egocentric ideas may be obtained from phenomena different

untolerated. These subdivisions coincide with the grammatical classes known respectively as "indefinites" and "interrogatives."

Grammar has further created a special pronominal group for what are known as reflexives. In the full discussion of the vicarious words it will appear that the reflexives are members of that class, distinguishable from the others merely by the somewhat restricted range of their employment. They require, therefore, no immediate examination.

The last of the grammatical pronoun-classes, the relatives, offer, on the other hand, peculiarities so extreme as to embarrass any merely introductory characterization. Deferring, therefore, their examination, I offer, in resumption of results thus far obtained, the following table of word-classes.



To a careless view this table might suggest the inference that the words of the several ultimate groups (linguacausate, etc.) outnumber the members of the single division of absolutes, the single title of the latter tending somewhat to mask their number. But were the absolutes also put to the torture, to wrest from them the secret of their differences, an overwhelming multitude of subdivisions would develop, each including an ample membership.[1] The absolutes comprise, in fact, the vast majority of every vocabulary; the half dozen grammatical pronoun-classes, and especially the true pronouns, contain but an insignificant minority.

Proposing now a more detailed examination of the word-classes thus far roughly sketched, I follow the order of con-

[1] For illustration examine any general classification of words according to their meaning, e. g., Roget's Thesaurus of English Words and Phrases.

venience, beginning with the [illegible]ious. On the back-ground afforded by these I will [illegible]ect the strongly contrasting relatives, following their examination with some discussion of the peculiar clauses which they render possible. The word-classes designated as pseudopronominal will be relegated to appendices, except the interrogatives, which I omit, it being my purpose to examine them in another paper, with the other means of interrogative expression.

CHAPTER II.—VICARIOUS WORDS OR TRUE PRONOUNS.

I. THOUGHT PHENOMENA IN WHICH THEY FIGURE.

It may be assumed of any thought, as "A exceeds B", that if any element, as "A", retires from my consciousness before I think of "exceeds B", I fail to form the thought expressed by "A exceeds B". That is, the elements of a thought must exist in the mind together; and this is true not only of myself but also of him who seeks to understand me. The success of the latter being first of all conditioned on attention, this is commonly accentuated as the hearer's duty. His duty is, however, plainly much more onerous. Not merely must he attend to my words and thereby attain their meanings; but further, what he thus attains he must retain, till all the factors of my thought are assembled in his mind.

It is less generally recognized that, were retention excessive, continued thought-reception would be impossible. To illustrate, having said that "3479 exceeds 1958", I wish further to inform you that "$9 \times 73 = 657$". I venture to predict that you will be quite unable even to harbor my second proposition, until you are mentally disencumbered of all that belongs to the first. Your duty as a hearer is then double. You must hold each element of thought presented, until all are delivered; you must also dismiss all, before attempting the reception of another thought. You must indeed hold fast; you must as truly also lay aside.

I do not mean however that, before the reception of a later thought, the elements of a prior thought retire beyond recall. If not too late, they may be brought back. By such a phrase as "the first mentioned number" I may still revive in your mind what I first suggested by "3479". This idea, it is true, withdrew from your mental stage, when the thought of which it formed a part was completed. But it did not go far; though what may be called the first scene of the colloquial drama was

ended, the actors remained behind the flies, awaiting a possible encore.

Using a homelier figure, conceive the hearer's mind as a slate. Upon it the speaker writes a mental equation, that is, a thought. This thought another thought shall follow. But the slate is small. Its room is fully occupied. To meet this difficulty, the sponge is run over the surface, giving room to write anew—not however the wet sponge; merely the dry. The old writing does not entirely disappear. It is only blurred. The new writing appears with great distinctness; yet the old continues legible. Another use of the sponge may be followed by the writing of a third equation. The slate may then contain such third equation fully distinct, a legible second equation, a first equation whose terms may still be deciphered. How many erasures a given idea may thus survive, it is needless to inquire. In actual mental practice the nature of the idea (abstract, concrete, etc.), its rank in thought-structure, the retentive power of the individual mind, contribute each a modifying influence.

The receiving mind is then a sort of palimpsest, ever fading, ever reinscribed. Each writing (except the first) is entered on a surface already covered by another but a faint and vanishing inscription. The new is much brighter than the old; but the old may yet be read, if the effort be not too long delayed.

II. THEIR DIRECTION FROM THE PRINCIPAL.

Examination thus far indicates that, in usual mental sequence, a vivid presentation of each idea is followed by a somewhat protracted fading, the idea becoming comparatively dim, before the expression of a new thought is begun. Conversely, just as sunset and succeeding twilight are inversely paralleled by dawn and sunrise, so also it is possible for the more vivid appearance of an idea to be heralded by an obscure prefigurement: vicarious words may faintly suggest an idea before its full revelation. Such symbols have already been distinguished as anticipative or prospective. They are illustrated by the sentence "Though *he* is very busy, *Brown* is going to Europe", "he" being a sort of linguistic x until its latent value is developed under the influence of "Brown".

It appears then that the proxy may take its place as well before the principal as after. The former usage, being somewhat unfrequent and rather artificial, may be neglected, as its examination reveals only results, I think, which are corollary or converse to those obtained by studying the more normal retrospectives. To these, accordingly, attention will from now on be specially directed.

III. THEIR DISTANCE FROM THE PRINCIPAL.

In reckoning this, the sentence-end affords a convenient landmark. No doubt, before this be reached, ideas begin to fade or, changing figure, to withdraw; yet, until it be reached, they must be clear enough and near enough to permit association with their fellows. Otherwise, the thought of the moment would be impossible. But, after the sentence-end, they must be so faint or so distant that they will not, unless invited, associate themselves with the ideas of a following thought. Otherwise such following thought would be confused.

Suppose now that an idea, under the stimulus of an initiative word, say "Brown", effects a first appearance in your consciousness. This mind-picture may be called an original. Of this original a copy may be needed, producible by "he". Further, as a matter of linguistic fact, this copy may be needed either before or after the sentence-end. Two cases therefore offer:

Case I. *Principal and Proxy in Different Thoughts—Reinstatement.*

To illustrate, "I just met *Brown*. *He* is going to Europe." It is plain that these sentences express two thoughts.[1] The first is self-sufficient without the second. The second requires no element of the first. It is true that "He" is inadequate, except so far as there be a prior idea for it to revive, an idea already adequately expressed by "Brown." But this inadequacy of "He" is a mere incident of its special symbolic nature. So soon as I substitute "Brown" for "he", my second sentence has no further need of my first. The second thought is

[1] The discussion of thought singularity and plurality is deferred, being much more necessary elsewhere.

complete and would remain so, were its predecessor quite forgotten. Whether I say, then, "He is going . . ." or "Brown is going . . .", my second thought and all its factors are the same; and this second thought in both cases is different and separate from the first. I may then safely say that the idea expressed by Brown (1) belongs to one thought; the idea expressed by Brown (2) or by "He" belongs to another thought.

The idea named by Brown (1) fades at the sentence-end to such an extent, that it will not appear in the second thought, unless recalled. Having said, "I just met Brown", if I continue with "I was wearing my new coat", you hardly think again of Brown. But if, instead, I continue by saying "He is going to Europe", the idea named by "Brown" is revived and serves again as part of my second thought. This idea serves then twice, once as part of one thought, and again as part of another. But it ended the first service before it began the second. Between the two it lost thought-membership. It was first established in attention by the initiative "Brown". At the sentence-end it was disestablished. It was reestablished or reinstated in attention by "He". Words which thus restore lost status, may conveniently be known as reestablishers or *reinstatives.*

Case II. *Principal and Proxy in the Same Thought—Coinstatement.*

That a given idea may be twice used in the same thought is indicated by the algebraic "$x^2 = 2x$". Wishing, in the examination of this usage, the advantage of comparison with the preceding, I use linguistic illustrations of both and put them side by side. Accordingly, as before,

Case I. "I just met *Brown. He* is going to Europe", and

Case II. "*Brown* has bought *him* a horse."

In several aspects these examples are alike. In both the proxy is retrospective. In both the idea named by "Brown" begins at once to fade and continues to fade until revival. This revival is accomplished in both cases by the same means and with the same success. That is, the idea is restored to its original freshness.

They differ somewhat in this, that the idea revived by "He"

requires revival—cannot otherwise serve with "is going to Europe". On the other hand, the idea revived by "him" does not require revival. It is still fresh enough, as presented by "Brown," to associate with its fellows, notably with "horse", although the latter appears upon the scene even later than "him". Accordingly the use of "him" cannot be explained by the necessity which leads to the use of "He". Although, then "him", as a matter of fact, revives the idea named by "Brown", this revival may be regarded as merely incidental, and not the special purpose of the speaker.

That purpose is rather as follows: having formed in your mind an original picture under the influence of "Brown"; having established this original in thought-membership (say as subject); while still maintaining this original in this membership, I wish you to form a copy of it, and to use this copy in a second membership (say indirect object) of the same thought. That is, while in Case I. I use principal and proxy in different thoughts, in Case II. I use them in the same thought.

The proxy as used in Case I., I have called a reinstative, that is, a vicarious word which gives back status to an idea which has lost it. Meaning now, per contra, a vicarious word which gives a second status to an idea still retaining a first status, I suggest the designation cumulative or *coinstative.*

Of words of this type a few have been ranked by Grammar as a special pronominal group under the title "reflexives." To illustrate, "Brown has hurt himself." In this sentence it is plain that "himself" cannot alone inform you who is meant, but requires the aid of a principal, namely, "Brown." That is, "himself" is vicarious. Again, the proxy and the principal serving in the same sentence, the former is what has been described as coinstative. As a reinstative, moreover, it cannot serve. I may not say, "I just met *Brown. Himself* is going to Europe," or "I was glad to see *himself.*" To this rule exceptions are, I think, apparent only. Thus, "I just met *Brown.* He professed *himself* glad to see me." In this sentence "himself" might seem to reinstate "Brown." But the only actual reinstative is "He;" it is this word that "himself" regards as its principal, without regard to "Brown." The action of "himself" is then as before coinstative.

Even as coinstative the use of "himself" is further restricted and, I think, to service of a first term, as in "*Brown* has bought *himself* a house," or "has hurt *himself.*" I may not say, "*Brown's* house suits *himself*" (unemphatic), or "To *Brown* the house of *himself* is pleas-

ing." Details and apparent exceptions I omit, as also any effort to settle how far, as claimed, those actions alone be reflexively expressed which recoil upon the actor. My interest ends with the proposition, that reflexives are coinstatives (possibly even sometimes reinstatives), which differ from others merely in the narrower range of their usage.

Another formally coinstative usage, commonly served by the same words as the last, is the emphatic. To illustrate: "*Brown* paid for the house *himself*." In this sentence it is true that I invite your attention to an idea a second time; but I do not do this because I wish this idea to obtain two thought-memberships; I wish it rather, in a single membership, to be in some way more effective. I may desire to make sure that you think of Brown, and not some other person; of Brown in his own personality, and not in that of some agent; of Brown in all his character, and not in any fractional exhibition. In short, I am merely extending the effort distinctly to symbolize my idea. So far as you think my idea over again, you do so merely to make sure of its being right. Such re-thinking does not concern thought structure; as it also is attended by no new mode of symbolization, it may be neglected in the present examination.

Principal, proxy, and their mental interim cannot be regarded as adequately examined without some notice of a peculiar usage, illustrated by the following words of the New England Primer:

> "*Zachaeus he*
> Did climb a tree
> His Lord to see."

The primitive aspect of such phraseology invites consideration of the difficulty encountered by primitive minds in the reception of a mental message. To exhibit this, suppose my barber to be linguistically backward, not indeed in talk, but in understanding the talk of others. As he begins to shave me, I remark "You have a new razor". I merely recall repeated experience, in supposing him to answer "Who, me?" Now it is perfectly plain to my questioner whom I mean; and his question is hardly put for the sake of obtaining further assurance. He asks it, I think, for the sake of gaining time; and he wants time, because I have rushed ideas upon him with a rapidity for his mind excessive. To become intelligible, I must reduce the speed of exposition.

In doing this I will omit the commoner expedients such as slower utterance, the use of bulky synonyms or paraphrases, the intercalation of what is unnecessary or may safely be inferred, the makeshifts, in short, of the embarrassed extempore speaker. I will merely meet in turn, by legitimate and strictly linguistic means, what may be ranked as legitimate needs of a mentally torpid hearer. I begin, then, my attempt upon the barber with "Ahem!" or "Say!", the latter being in this case not a superfluous hint to say anything, but the announcement that I am about to say something myself. My utterance corresponds to the

military order "Attention!" Proceeding circumspectly, I next say "John!", from which vocative my hearer learns that what I am yet to say will be directed to him; that it is time to put on his thinking cap. My warning, now double, being both general and personal, answers to the specialized "Attention, Company A!" I next ejaculate "Razor!", thereby indicating that what I am to say will concern that tool of the barber's art. So, too, in military practice, a considerate captain might amplify the ordinary "Attention, Company A!" by hinting the general nature of the order about to follow. The barber is now aware that I am going to talk—to him—about a razor. He is amply prepared for the statement "You have a new razor". I may look with some confidence for an immediate answer.

Of all such preliminaries I invite especial attention only to the last, the one which advertises the coming topic, the precursory or prodromic theme-namer, the colloquial "mise en scène.". The import of this may be expressed by the sentence "Razor is to be talked of" or "I am going to talk of a razor". But economy or brevity commonly reduces the sentence to a phrase or even a single word, as for instance, "Speaking of razors", "apropos of razors", or merely "Razor". Such reduction of course establishes no sentential fellowship between the precursory theme-namer and the utterance which follows. That is, "Speaking of a razor" has nothing more to do with "You have a new razor" than did "I am going to talk of a razor". Yet, just as weaker men of old became the vassals of feudal superiors; just as words of scanty meaning, volume or importance join their betters as proclitics or enclitics; so also the mutilated sentence, or say the residuary phrase, unites itself with its unimpaired neighbor.

The same is true of a single residuary word. Thus the sentence "I am going to speak of Zachaeus", used as a preliminary namer of my coming topic, may be reduced to the single word "Zachaeus". This word, unable thus alone to functionate as a sentence, formally allies itself to the following sentence, producing "Zachaeus he did climb etc." The alliance is not however structural; for, given "he" as occupant of the subject-place, no other place remains for "Zachaeus". In fact "he" is "Zachaeus", which is but saying that "Zachaeus" is already in the only place that "Zachaeus" can occupy. It seems therefore just to say that in "Zachaeus he did climb, etc." the presence of "Zachaeus" is purely adventitious; that the word is properly a mere residuum of a prior sentence.

The different relations of a principal to the sentence containing its proxy may be illustrated as follows:

(1) "*Zachaeus* saw *his* Lord." The principal is in the proxy's sentence and of it.

(2) "*Zachaeus he* saw his Lord." The principal is in the proxy's sentence but not of it.

(3) "I am going to speak of *Zachaeus. He* saw his Lord." The principal is neither in the proxy's sentence nor of it.

In (2) the principal is held by Grammar to be of the nominative case. Experience, however, justifies the interpretation of this verdict as meaning merely that the word is spelled with the same letters as when it names the subject. It surely has no other claim to nominative rank. It attends in fact to none of the duties performed by the different cases. In particular it gives no hint of how its idea will be used in the structure of any thought. For if the thought of which that idea is a constituent factor, were what I express by "Zachaeus is my topic", no doubt Zachaeus would be planned to serve as subject and would properly rank as a nominative; but if that thought were rather "I am going to discuss Zachaeus," no doubt Zachaeus would be planned to serve as object and could not rank as nominative. Again, of the thought whose expression begins with "he", "Zachaeus" does not foretell the subject or the object. I may indeed be about to say that "he climbed"; but I may also be planning "a tree upheld him", etc., etc.; in fact I may not even myself have determined the structure of this thought.

The use of nouns in book and chapter titles is much the same. In these the noun does not, indeed, by force make room for itself in the following sentence, and its forewarning purpose is not so special; it does, however, suggest the general nature of what is to follow. It is also true of every principal that it may be taken as a warning of its proxy's meaning. When such becomes its special purpose, through the renunciation of other purposes, it may be recognized by a special designation, such as propositive, introductory or titular. As indicated above it is really a caseless form, a proposition of an idea, that is, in blank, without any of the various further conceptions which Grammar has grouped in the category of case. Yet, if that must be known as case which really is no case, it would be less confusing to call the principal, in the now considered usage, a titular or propositive case, than to call it nominative.

If it be conceded that "Zachaeus he did climb" is a mere curtailment of "I am going to speak of Zachaeus. He did climb," it is obvious that after "Zachaeus" a breach of thought occurs in both expressions. Strictly then the former should be written "*Zachaeus. He* did climb etc." It would be the merest corollary to add that "He" is reinstative; that is, an idea named by Zachaeus disappears at the end of a first thought or rather a fragment thereof; the idea reappears in another thought under the influence of "He".

I feel however that the usual thought-procedure is different. The mind of the people seems to persuade itself that what it seeks to express by "Zachaeus he did climb" is a single thought. That such is indeed the popular persuasion, is indicated by the popular utterance of the sentence. This may be indicated in writing as follows: "Zachaeus he did climb." What may be the actual structure of the thought so oddly

expressed, I am peculiarly unfitted to say, as the phraseology has never been part of my expressional outfit. I have therefore no attendant thought to name as even my individual meaning. All that I can offer is a suspicion, as follows: From a mere propositive, "Zachaeus" has become legitimate subject. From the rank of subject, "he" has descended to that of an explainer, distinguishing the subject as a person (antagonized to "it"), as masculine (antagonized to "she") and as nominative (antagonized to "him"). That is, this usage merely exhibits a stage of the process by which the personal pronouns, first appositively associated with nouns and next emptied of their meaning, finally annex themselves as case-endings. The present phenomenon, thus construed, is merely a case of arrested encliticism. A vicarious word, primarily reinstative and later coinstative, is in value somewhere on the line of development into an inflectional suffix.

I have thus far adhered to the plan of examining proxies only in their retrospective aspect. As a mere suggestion of the completeness with which such examination might be carried out, I note that also the anticipative proxies may be differentiated, according as the idea rudely prefigured by the proxy does or does not lapse before its completer exhibition by the following principal. Thus, suppose you enter my room as I utter the words "He is very ill". The word "He" is reinstative to another auditor, possessed of my previous utterance; but in your case the word must be treated as anticipative, if you are to understand my meaning. I accordingly add "I am speaking of Brown". To you, then, "He" is a proxy of the prospective order. Also, if you think as I do, the idea expressed by "He" is allowed to lapse (to the degree at least of clearing the way for ideas possibly yet to come) before the appearance of the principal "Brown." The office of "He" may be distinguished then as predictive, preinstative or *annunciative*.

In "His illness alarms Smith," the "He" contained in "His" appears again as a proxy and again prospective. Its idea does not, however, lapse before the appearance of "Smith." It may be distinguished as inceptive or *inaugurative*.

The two prospective usages may be illustrated as follows: the annunciative office is that of Isaiah the prophet, long foretelling the Messiah's coming; the inaugurative is that of John the Baptist, accompanied by the One foretold. The annunciative is an advance agent, the converse of a reinstative. The inaugurative is rather an usher, the converse of a coinstative.

IV. THEIR SIMULTANEOUS SERVICE OF DIFFERENT PRINCIPALS.

Suppose a series of ideas to be expressed in turn by successive initiatives; it lies within the power of one vicarious word to serve as simultaneous proxy to them all. To illustrate, "I just met *Brown*, *Jones* and *Robinson*. *They* were on their way to the Court-House". In the latter sentence "They" reinstates at once each one of the ideas expressed in turn by "Brown", "Jones," and "Robinson".

In doings of this sort the vicarious words accommodate their scruples to the service of masters not only many, but also different in sentential status. Thus, "A year ago *I* (subject or first term) introduced *you* (object or last term) to *Brown* (indirect object or adjunct of mid-term). *We* were rather gay that night."[1]

Such difference of principals may be even greater. Thus, "*Blue* is the color of Yale. The Harvard flags are *crimson*. *These* are famous colors." "These" presents vicariously and in substantive function the ideas expressed by "blue" and "crimson". But of these ideas the former was, as principal, a noun, and the latter an adjective.[2]

V. THE COMPLEXITY OF THEIR PRINCIPALS.

I have in mind at present the case in which two or more ideas, structurally built together, are treated as a unit, and presented a second time by a vicarious word. In the previous case the proxy might be said to serve one or more individuals. In the present case it may rather be said to serve a society. To illustrate, "The physicians declare the daughter of Brown to be insane. *He* is greatly depressed. *She* is his youngest child. *It* is very sad." In this sentential series "He" reinstates "Brown" and "Brown" only. "She" reinstates "the daughter of Brown". "It" reinstates the plexus expressed by "the daugh-

[1] It will further be noted, in the appendix on personals, that also the lexical values of principals are, in this case, very different.

[2] This inaccuracy is repeated and extended in the interest of brevity. Strictly the ideas noted have in thought that function which gives to their corresponding words the sentential rank of noun and adjective.

ter of Brown to be insane". Differentiating by another figure of speech, I may say that "He" pulls out a single stone from previous thought-masonry, to use it in succeeding structure. "It", on the other hand, cuts from previous thought-masonry a section made up of several stones and moves it in block, without disintegration, into a succeeding structure.

VI. THEIR FIDELITY TO THE PRINCIPAL.

By this I mean the exactness with which the proxy repreduces the idea suggested by the principal, either in extent (that is, its quantitative aspect) or in content (that is, its qualitative aspect). Fidelity, in other words, may have to do with either number (or bulk) or kind. Confining examination to the former as more tangible and as showing all the variations found in the latter, I note that the strictly faithful proxy presents an idea in the same numerical aspect as its principal. Thus, having said that "I just met *three soldiers*", if I add that "*They* were in uniform", you assume that I mean the original three, no more and no less. Such vicarious service may be known as complete or *equivalent.*

The vicarious word, however, sometimes augments the scope of its principal. Thus, "I saw a *tiger* yesterday. In fact I have seen a great many of *them.*" "A tiger" distinctly contemplates a single animal. "Them" reinstates this individual, but adds thereto the remainder of the species.[1] Such uses of vicarious words may be known as excessive or *augmentive.*

The vicarious word on the other hand may diminish the scope of its principal. Thus, "*Birds* are bipeds. *They* have been known to be also bicephalous." By "Birds" all individuals of the order are plainly intended. "They," however, includes assuredly some birds only. Again, "Brown *overslept.* I expected he would do *that.*" "That" reinstates the idea of oversleeping, but not the idea of past time or the personal belief (assertion) expressed by "overslept". Vicarious words of this sort may be known as incomplete or *reductive.*

[1] Again " I just met Brown. His son is ill." "His" reinstates "Brown" and does this business accurately; but at the same time "His" goes into business on its own account, presenting initiatively an idea of say possession, expressible by "of." As thus presenting more ideas than its principal, "His" also may be ranked as in a sense augmentive.

The proxy of this type may reduce the number of the ideas expressed by its principal to unity or even to zero. To illustrate, "There was a bridal *couple* on the train. *They* seemed ill at ease. *She* was dressed in white. *Neither* was very young." Of the proxies employed "They" is equivalent, having exactly the scope of "couple". "She" is reductive, reinstating a single member of the original pair. "Neither," strictly taken, is what may be called *exclusive;* that is, the number of conceived persons, describable as very young, is zero.[1]

The proxy may even both reduce and augment, in a single vicarious act. Thus, "An *elephant's* trunk is a useful member. With it *they* perform the most delicate operations." Without discussing the elegance or expediency of such usage, I note that "elephant's" presents initiatively a single individual and further the idea say of possession. "They" omits the idea of possession and expands the individual into the species.

VII. THEIR FALLIBILITY.

Where many eligible principals occur in close succession, it may or may not be evident, which one a proxy is intended to serve. There is, indeed, a tendency to regard the dominant word as principal; but this is offset by another tendency so to regard the nearer; and either tendency may be abrogated in favor of a word neither near nor dominant. This embarrassment may be relieved when the principals differ, as in number and gender. Thus, given "Brown's sister has bought a horse. He, she, or it is in the country", each proxy is available for a single principal only. But given "Brown's brother has heard from Smith's nephew. He, by the way, is going to Europe," "He" may reinstate the idea expressed by either preceding noun; and, barring special knowledge of the speaker's linguistic methods, it cannot be determined which possible principal is actually served by "He".

This difficulty, which may be known as that of *the which,* is matched by another, which may be known as that of *the how*

[1] The policy of ranking words like "neither" as negative (in the sense in which "not" is negative) is matter for interpellation in a special review of linguistic negation.

much. When the proxy serves a plexus of ideas, it is often quite impossible to determine the extent of that plexus. Thus, "The papers declare Brown to have announced himself to be unable to pay his debts. I didn't expect *that.*" In this example "that" may stand for the whole or a part of the preceding sentence; and the part may be large or small. Thus by "that" I may mean "Brown to have announced etc.", or "Brown to be unable etc.", or even "Brown to be able etc."

VIII. THEIR SERVICE OF VARIOUS PARTS OF SPEECH.

In this section I invite an effort to find, if it may be, with Grammar's own eyes, the reinstated sentence-elements (or parts of speech) which grammatical vision has overlooked. Conforming then, so far as in me lies, to Grammar's categories, and confining myself for the moment to vicarious substantives, since Grammar recognizes these alone as pronouns, I first recall that the use of such vicarious words to reinstate preceding *nouns,* has already been amply illustrated. Similar reinstatement of substantives classed as *pronominal* may rank as the merest corollary. Thus, "*That* is my hat. *It* can't be yours."

Some tendency Grammar shows to the opinion that other parts of speech are not thus reinstated. That, however, which words (grammatically ranked as pronouns) do actually reinstate, is often an *adjective.* Thus, extending illustrations beyond that which perhaps alone ought to be and including what linguistically is, "*Red* rags enrage bulls. *That* is unfortunately the color of my hat," or "The flag is *red. That* (or *it*) is a beautiful color."

Even the idea expressed by the enfeebled ego-centric known as the definite *article* (derived from *that*) is not unfrequently reinstated. Thus, suppose you utter the word "Browns"; it may suggest to me a considerable number of families. But if you say "The Browns", I at once restrict the scope of the word to the particular family foremost in our common acquaintance. Let now your statement be "*The Browns* have sailed for Europe". I reply: "*They* are great travellers". By "They" I mean not merely what I have learned from the word "Browns", but also what I have learned from the word "The"; that is, I

reinstate by "They" the idea initially expressed by "The". The further reinstatement of what was suggested by "Browns" is merely so much ordinary multiple symbolization. Again, if my answer be "*Those* Browns are great travellers", the reinstative action of "Those" appears to be confined to what was expressed by "The." My example however suffers now in cogency from the fact that Grammar commonly fails to note the vicarious and therefore strictly pronominal value of "Those."

The reinstated idea is often primarily *verbal.* For instance, "He said that he *hurried.* But he never did *it* in his life."

That the verbal adjective or *participle* should also be reinstated is a foregone conclusion. Thus "*Hurrying* people are subject to accident. You needn't worry about Brown; he never does *that* (or *it*)."

The verbal substantive or *gerund* is also subject to recall. Thus: "Brown's *hurrying* caused his accident. He is not often guilty of *that* (or *it*)."

The vicarious presentation, in substantive function, of an idea initially *adverbial* is less common and should perhaps be noted merely as a possibility. Thus, "Brown is walking very *rapidly. That* (or *it*) does not often characterize his movements."

Much the same may be said of ideas initially *prepositional.* Their reinstatement in substantive function may be illustrated as follows. Suppose you ask me, "Is Brown *in* the house or *in* the barn?" I may answer, "He is *that* (or *it*) in respect to neither." Thus guarded, my statement seems to bar the application of "that" to any other idea than what was expressed by "in."

To reinstate an *interjection* by a recognized pronoun seems a rather unlikely feat; yet it is performed at least with quasi success. For instance, speaking of a notorious public enemy, suppose you say: "*Alas!* He is dead." I answer: "*That* is not my feeling."

Conjunctions are unfortunately much confused with prepositions and adverbs; I think, however, that I respect grammatical opinion in giving the conjunctive rank to the word "but" in the following illustration. Meeting me in the guest-room before a dinner, you remark: "Miss X. is to be here. *But* I have

come." To this I answer: "*That* doesn't describe your coming at all. It is *because* she is to be here." The thought expressed by remark and answer seems to me to be as follows: "But" expresses addition of a discordant type, addition of the preceding thought, addition to "I have come." The full meaning, then, of the second sentence is, "I have come in spite of Miss X's prospective presence." Condensing and redraughting thought perspective, I obtain "My coming is *but*" or antagonistic (to her expected presence). In the same way my answer resolves into the following: "*That* (namely, antagonism) doesn't describe your coming. It is resultant" (or because of her prospective presence). While this use of "that" may stretch conventionality, it does not seem to overtask the powers of the reinstative. I therefore think it not too much to say that the reinstatement of a conjunction by a pronoun is at least a linguistic possibility.

IX. THEIR SERVICE AS VARIOUS PARTS OF SPEECH.

The following section aims to observe the reinstatives in their use as different sentence-elements (parts of speech), including, therefore, many uses to which Grammar has closed its eyes, refusing to recognize as pronouns any but substantive words.

That the vicarious word may be used as a *noun* has been abundantly shown in Section VIII. That in such usage it is separately ranked as a *pronoun*, has been noted as a mere vagary of Grammar.

That it is also used as an *adjective* appears in the following illustration: "Are the flags *red?* They are *that.*"[1]

Its use as an *article* is somewhat less assured. But suppose you ask, "Where are my shoes?" and I answer, "*The* shoes are under the table;" it is possible at least that "the" be taken as reinstating the idea expressed by "my." For, had I said: "They are under the table," "they" would surely be regarded as reinstating "my shoes." Now this possible "they" and the actual "The shoes" of my answer seem to be synonymous.

[1] French Grammar has been much embarrassed by such failure of usage to abide by the dictum of syntax, sometimes ranking "that" (*le*) as a pronoun and sometimes, for reasons not easy to imagine, as an adverb.

"The shoes" may then, as well as "they," be regarded as a reinstatement of "my shoes." In such reinstatement obviously "shoes" reinstates "shoes only;" accordingly the reinstater of the remaining "my" would seem to be the article "The."

The *verbal* use of the proxy is well-nigh theoretical only. To the question whether Brown sawed or chopped his wood, language might provide an intelligible answer of the form, "He thissed it," or "He thatted it." But, so far as I am aware, approximations only to such usage have been noted in actual practice. Thus, if you ask whether my son *stammers,* I may answer, "He *does;*" and while it may be argued that "stammer" is understood, there is some reason for believing that it is not, or at least not always. Latin sometimes allows a similar usage with "facere;" but "facit bulbutire" would not be tolerated in the sense required.[1]

Obviously such verbal usage of the vicarious word may readily become *participial* or verbally adjective.

It may also plainly become *gerundive* or verbally substantive.

The *adverbial* use of the proxy is very common, though not always recognized by Grammar. To illustrate, suppose you say of your horse that "He walks *rapidly.*" I answer that "My horse walks *so* too."

Prepositions are constantly repeated without linguistic squeamishness. Thus if you ask whether I was in the house or in the barn, I answer that "I was in the house", without fear of giving offense by using so soon again the unobtrusive "in". The reasons of this exceptional toleration need not be demonstrated. The fact itself discourages the search for prepositional proxies. The possibility of reinstating by a preposition may be suggested, however, as follows: Suppose you enter my room as, in answer to a previous question, I utter the words "By me". To your mind the word "by" suggests no doubt an idea; indeed it is likely to suggest several. It may mean "near", as in "He sat by the fire; it may mean "alongside of", as in "The path runs *by* the river"; it may mean "past", as in "He walked *by* my door". As a matter of fact I use it in the present case with none of these meanings. While then it can, it is true, make abundant suggestions, it is unable of itself to specify the right idea. If however this right idea be previously presented by an initiative, the word "by" can reproduce it exactly. To

[1] Conf. "He does not stammer: but he bids fair to." In such expressions it has been claimed that "to" has the value of "to stammer;" that is, "to" is regarded as vicarious and is verbally employed.

show this, I expand my illustration as follows: "Through the agency of whom was the glass broken? *By* me." In this expression it appears that "by", though unable alone to suggest intended meaning, succeeds in accomplishing the expressional purpose through the reinstatement of the idea initiatively named by "through the agency of." That is. "By" may be said to illustrate the possibility of reinstatement by a preposition.

The reinstative use of the *interjection* is also essentially theoretical. Its possibility may be illustrated as follows: The isolated "Ah!" suggests many possible emotional states. If the extra-verbal aid of vocal tone, facial expression, etc., be excluded, "Ah" alone is unable to express a particular emotion. But by the aid of initiative words it may do so. Thus "Brown *alas*! is dead. *Ah*!" The emotional status, expressed by "ah!" unaided, might be that of joy, or sorrow. As a reinstater of what was meant by "alas!" the word "ah!" is entirely adequate. Again, to your "Hallo!", meaning "I want your attention", I answer "Aye!", meaning "You have my attention". That is, the interjectional "Aye!", in part at least, reinstates what was expressed initiatively by "Hallo!"

The vicarious use of the *conjunction* is clearly shown in French by one of the uses of "que." While no doubt this word may often imply an ellipsis (as of "lors," when standing for "lorsque"), and while it may strictly even imply a new construction (as when taking the place of "si"),[1] nevertheless the grammars no doubt are right in claiming that, to the average mind, the value of "que" is merely that of a repeater, that is, a reinstative, bringing in a second time an idea initiatively expressed by another word.

X. EXTENT OF VICARIOUS USAGE.

Under this caption I invite a moment's attention first to several strictly vicarious uses of words which Grammar has ranked as personals. Of these the words "I" and "thou," as indicated later, commonly stand directly for the person intended, without the aid of any initiative presentation. In written or, say, epistolary language they may, however, be regarded as vicarious. Thus, in a letter which you have written, finding the word "thou," I do not know whom it intends, unless I read the preliminary "J. B. Smith, Dear Sir." It is possible, therefore, in this case to rank your "thou" as vicarious and of the retrospective type.

[1] Conf. "Si vous venez et (supposé) que je ne sois pas chez moi."

Also, if there be in the letter an "I," it is uncertain whom it intends, until I read at the letter's end, "Respectfully yours, H. C. Brown." It is possible, therefore, in this case, to rank the "I" as vicarious and of the anticipative type. "He," "she," and "it," as also "we," "you" and "they," are almost always vicarious, as in the frequent illustrations already given. The exceptions are treated in the appendices.

The vicarious use of so-called demonstratives has been, I think, sufficiently indicated. That words regarded by Grammar as indefinite pronouns may serve in fact as proxies appears in the following sentence: "A sower went out to sow his seed, and as he sowed, *some* fell by the way-side." That the reflexive is always vicarious has been already argued. That the usually relative word may be vicariously employed is apparent in the sentence: "Ils cherchèrent ....., *qui* d'un côté, *qui* d'un autre" (Balzac). That even the interrogative may be in part, at least, vicarious will probably be conceded in "Here are two apples. *Which* will you have?"

The following sentences exhibit a cluster of words, whose powers, though distinctly vicarious, are more or less in danger of being overlooked. "Brown and Smith can't agree. *The former* dislikes *the latter*. *Each* distrusts the *other*. *Neither* has reason. I would trust *either*. *Both* deserve confidence, *one* as much as the *other*." Speaking, again, of a larger group of persons, I might remark: "*All* are my acquaintances. *Many* are my friends. *Few* dislike me. *None* are my enemies."

The vicarious symbol is also readily overlooked, when disguised, as often happens, in a compound. Thus: "Brown gave me a *book*. *Therewith* (= with it) I was greatly pleased. *Therefrom* I have learned much. *Thereto* my thoughts recur. *Therefor* I have thanked him." The differentiation of these words being a lexical matter, involving no fundamental principle of idea-presentation, may be neglected.

Much deeper suggestion is offered by the frequent vicarious use of "such." To illustrate, my bookseller writes: "You ask for *novels*. I send you a dozen *such*." In this example the vicarious action of "such" is of the ordinary, simple type. On the other hand, in the phrase, *Soldiers, sailors* and *such*," the

idea-presenting power of "such" is only in part vicarious. That power, in fact, is the same as that of "persons like them," in which "soldiers" and "sailors" are a second time presented by "them," while "persons like" are presented initiatively. Again, "Suffer *little children* to come unto me.....For of *such* is the kingdom of Heaven." "Such" in this case stands, I take it, for two groups: first, by simple reinstatement, for "little children"; second, for "persons like little children," this latter group being obtained by a second reinstatement of "little children" simultaneous with the initiative presentation of "persons like." That is, "such" accomplishes one initiative and two vicarious presentations.

The multiple activity of the vicarious word is even more noteworthy in the following illustration: Suppose that two children have just figured at a school commencement; one is a boy and the other a girl; they belong to different families; the mother of one and the father of the other are present. I may then very well say, (1) "Mr. A. has witnessed the graduation of his boy,"[1] using "his" at the same time to reinstate "Mr. A." and initiatively to express a relation hardly possessive, indeed more strictly parental; (2) "Mrs. B. has witnessed the graduation of her girl," in which "her" reinstates "Mrs. B." and initiatively indicates the parental relation. The two parental relations are, however, quite independent, as each concerns a different pair of terms; indeed, we strongly tend to differentiate them qualitatively. I am hardly hair-splitting when I specify the former relation as paternal and the latter as maternal. Assuming this differentiation to be conceded, I note that what I have expressed in two sentences is commonly put in one, as follows: *"Mr. A.* and *Mrs. B.* have witnessed the graduation of *their* boy and girl," a sentence in which *'their"* accomplishes all that was effected by *"his"* and *"her;"* that is, *"their"* makes two reinstatements, while initiatively expressing two different relations. The complexity of the feat performed by "their" may be emphasized in the following algebraic paraphrase: given $a > b$ and $c < d$, it is required to express a, c, $>$ and $<$ by a single symbol.

Other symbols, though conspicuously vicarious, are sometimes

[1] I avoid the word "son" in order to throw all relation indication upon "his."

overlooked by Grammar, when they chance to be adverbial. That the adverb may indeed be vicarious was intimated on p. 31. In further illustration I offer the following sentences. Suppose you say: "Jones acted impolitely." To this I answer: "I don't think he acted *so* at all." "So" reinstates "impolitely." Again, answering your question, "Does Brown dine here?" I answer: "He dines *elsewhere;*" that is, I name by *"elsewhere"* place distinguished as different from this place ("here"); in other words, the symbolic value of *"elsewhere"* is partly reinstative and partly initiative. So, too, in "Brown eats with a fork. Jones eats *otherwise,"* the last word indicates a method different from that indicated by "with a fork." Again, to your statement that "Brown is rich," I answer, "He is handsome, *too, likewise, also, withal, besides,"* meaning by "too" (or any of its successors) "in addition to rich."

It has already been remarked that the pronouns, instead of reviving a single idea, may revive an ideal plexus. It is natural to expect that such a plexus should sometimes have the nature and the fullness of a thought. So far as the vicarious word is in such a case conceived as a "thought-connective" or sentence-joiner, it has been examined in another paper, in which it is argued that the thought of a first sentence is substantively reconceived and put by the connective in oblique or adverbial association with the verb of the second sentence. To illustrate, "He invited me...*Therefore* I came." "Therefore" dissects into "for (= from) that," the latter being a reinstative and the former a relation-namer, the two together forming an adverbial adjunct of "came." That is, "my coming" is conceived as "from (= on account of) his inviting me."

The thought vicariously presented may enter the structure of a second thought in several ways, for instance, as its first term or subject. Thus, to your statement: "Brown is ill", I answer *"That* (i. e., Brown's being ill) surprises me". Again, the first thought, being reinstated in the second, may be its last term. Thus, answering again your "Brown is ill", I say: "I regret *that*". "Je n'*y* crois pas" presents the illness of Brown as an indirect object or dative. "J'*en* suis fâché" offers it as genitive of source or ablative of cause. In short, the various relations indicated by case forms are assumed by reinstated thought.

The vicarious presentation of thought thus far considered has been

of the retrospective type; it may also be anticipative. To illustrate, wishing to put before you the proposition that France will fight, and wishing further to put it that people say this, I am likely to begin with the expression "People say". At this point I find it convenient to introduce a provisional object, namely "that". This object has the advantage of being accustomed to objective function, whereas the expression "France will fight", though my actual object, is accustomed to rank as a sentence, and does not readily resign itself to being the mere object of another sentence. The word "that" is no doubt inadequate, because indefinite; but this very indefiniteness is so extreme as to give sufficient assurance that it does not express all that I intend. The sentence "They say that" is surely far from worth the effort of expression. You safely argue that more is yet to follow. You accept my "that" as a quasi promise of further and more definite expression. In other words you recognize my "that" as a mere prelude, as an anticipative proxy. And when I continue with "France will fight", you readily accept these words as the proxy's principal—as the definite expression promised by "that".

Such I mean is the original and clearer conception of "that," as indicated by its history in several languages. In time the word has been largely emptied of meaning and has sunk to the level of a sign that the following thought is merely a substantive factor of another thought. Occasionally in Spanish, the equivalent "que," having many other possible values, is reinforced by the article. Such usage renders obvious a structural displacement of "that", which has passed from an earlier full membership of "People say that" into ancillary membership of "that France will fight". This change too is further accompanied by change in punctuation. The sentence, as originally constructed, would be written "They say that—France will fight". As now construed it is written, when at all protracted, "They say, that France will fight".

In the present illustration the anticipative "that" is last term or object. In "That France will fight is commonly believed" it is subject. In "They do evil that good may follow" it is indirect object or say a dative of purpose. In "I am sorry that he is ill", it may be regarded as ablative of cause. It is in all cases the result of mere neglect, that the anticipative "that" is uninflected.

When the original anticipative value and the full structural significance of "that" have once been forgotten, the purpose of its introduction naturally seems to be unfulfilled, and therefore may be carried out a second time. Thus primarily one would naturally write "That—(namely) France will fight—is generally believed" or "That is generally believed—(namely) France will fight" or even "Is generally believed that—(namely) France will fight." But so soon as such interpretation of the last is reached, as may be expressed, with change of punctuation, by "Is generally believed, that France will fight;" that is,

so soon as "that" is regarded as a mere sign of substantive usage, the main sentence is left without apparent subject. The blank may then be filled by the anticipative "It", with the following result: *It* is generally believed *that* France will fight." Also rearrangement permits successive use of both anticipative and retrospective proxies as follows: "As for *this*, *that* France will fight, *it* is generally believed". That is, historically rendered, the fighting of France is anticipated by "*this*" and by "*that*" as well as retrospectively repeated by '*it*".

The conception of "that" as a "conjunction", required to connect the following clause with the principal, is obviously untenable and actually losing favor. If saying needs joining to what is said, I see no reason to doubt that eating needs to be joined to what is eaten. And conversely, given "The boy ate the pudding", if I can dispense with a bond of union between the boy's eating and the pudding, so also in "They say that France will fight" I doubt not that I can do without a conjunction between "their saying" and "France's fighting". The error of Grammar lies however deeper than these suggestions indicate, and deserves a moment's attention in view of its bearing on the general problem of conjunction. It lies in conceiving the saying and the fighting as in a condition to be joined, that is, as separate. In fact they are members of a single sentence, one utterly unfaithful to my purpose, if either member be omitted. "They say" does not tell you what I mean or any self-sufficient part thereof; the same is true of "France will fight". These two are parts of one whole and accordingly as closely joined as thought and speech can make them. For the utmost union that any factor of thought or sentence can establish with its fellows, is attained so soon as it is recognized as indispensable to what is intended. Union and junction are really the merest figures of speech. The reality of the case is indispensability. Now of all the words in my illustration one only can be omitted without injury to my thought or its presentation, namely, "that".[1] Yet on this word, of all my words the least necessary, Grammar lays the burden of performing the conjunctive act. That is, in extremely objective parlance, the word "that" does not stick, itself, to either part of my sentence; yet one of the parts thereof it shall, as Grammar will have it, stick to the other. It is, in other words, expected to glue two things together, without itself adhering to either.

The vicarious function is somewhat more obscure in "Yes" and "No." To illustrate this, suppose you ask me, "Is Brown ill?" and I answer, "Yes." I think it will generally be ad-

[1] When "that" is left out, it is the merest begging of the question to claim that it still is present in thought. No such claim is made with a direct quotation. Yet such quotation consists of the same thought as the indirect, being merely further conceived as in the words of a particular individual. In short the direct quotation, as the larger addendum, should require the stronger bond of union, and presumably can least dispense therewith.

mitted that "Yes" means "Brown is ill." In expressing this meaning, "Yes" might reinstate preceding thought as a total, in two parts or in three. If the last, the most difficult method, be the one pursued, I must find in "Yes" three factors, say (1), (2), and (3), which respectively reinstate "Brown," "is," and "ill." But the "is," being easily supplied, is therefore often omitted. It may be, then, that "Yes" contains only (1) and (3). Assuming such to be the case, let "Hoc" take the place of (1) and "illud" the place of (3), developing "Hoc—illud," with the understood value of "Hoc est illud," namely, "This (i. e. Brown) is that (i. e. ill)."[1] This combination, historically familiar, produced by successive changes, "o—il," "ou—il," "oui." That is, and I argue nothing more, the "oui" is conceivable as a simultaneous reinstatement of those preceding thought-factors, which are regarded as most necessary.

That "hoc" may rather reinstate the whole preceding thought, being merely reinforced by "illud," or vice-versa, I should not seek to disprove; I would even admit that different minds may have used this linguistic mechanism differently; I imagine, too, that minds have utilized other expedients for reaching the results accomplished by "yes" and "no." For instance, such a word as "truly" may add to the power of initiatively suggesting truth the power of reinstating what is conceived to be true; and such procedure would justify, so far as it goes, the grammatical practice of ranking "yes" and "no" as affirmative and negative adverbs. All that I wish to emphasize is that the affirmative and negative idea, to be of use, must be juxtaposed in mind with what is affirmed or denied. In the case of "yes" and "no" this requirement involves the reinstatement of preceding thought. In the absence of other means, this reinstatement must be effected by these words themselves. That is, the so-called affirmative and negative adverbs express all that is expressed by affirmative or negative propositions. They properly rank then, as others have noted, not as parts of speech, but as sentences.

XI. THEIR ORIGIN.

This may very well have been of many kinds. For instance, the initiative may have changed into a vicarious symbol. Conceived as a mere

[1] Conf. "That's it."

possibility, such a change may be illustrated as follows: given "this" and "that," meaning initiatively the near and the far of space, by a well-worn path of idea transition they become the near and the far of time, and these have but a line to cross to become the near and the far of consciousness. Accordingly "this" coincides with an idea of which I am thinking or am vividly conscious; "that" by antagonism associates itself with an idea already distinctly thought and now waning, or yet to be thought distinctly and now but dawning—an idea then, in either case, of which I am at this moment conscious but dimly. Many reasons might be alleged in favor of a preliminary leaning in favor of what has been thought already; that is, the use of the vicarious word was at first presumably retrospective. Suppose then I say: "Brown was married on Christmas. *That* is my birthday." My meaning is as follows: *That* (of which I *was* thinking, i. e., Christmas) is (this of which I *am* thinking, necessarily specially symbolized as) my birthday. "That," being primarily used of things, tends to overlook an idea so unobjective as marriage; the choice between "Brown" and "Christmas" is settled by number, gender, adaptability to context, etc.

XII. THEIR MOTIVE.

The vicarious word is rather a linguistic luxury than a necessity. It may always be replaced by its principal; but such use of the latter involves an obtrusive repetition, and to this a dislike is early developed. Thus I may, with perfect exactness, tell you that "Brown says Brown's brother has sold Brown Brown's brother's horse;" but the fastidiousness of speech is offended. Preference is given to "Brown says his brother has sold him his horse."

XIII. THEIR INCIDENTAL ADVANTAGES.

A suitable corps of idea-repeaters aids correct understanding. As soon as they are fully recognized as such, they give notice that what they name has been named before. Initiatives, on the other hand, create an expectation of the new. Thus, suppose I say, "I have been talking with *Brown*. I learn that *my neighbor* is ill." As a matter of fact "my neighbor" and "Brown" are one person; but this you do not expect, because "neighbor" is usually employed to name an idea different from

its predecessors. To use initiative words for old ideas is, then, to thwart expectation. I should do better to say, "I have been talking with Brown. I learn that *he* is ill." When old ideas, then, are intended, their reception is aided by the use of reinstatives, words, that is, which announce the old as such. The gain attending the use of idea-repeaters is accordingly this: the speaker is able to announce each idea in its turn as old or new, thereby reducing the field in which the hearer is to seek the idea.[1]

The use of idea-forerunners may aid the receiver of thought-elements in their right assemblage. This advantage, already intimated on p. 36, may be illustrated more completely as follows: "France will fight is thought by many." In this sentence you are embarrassed by difficulty in determining what my subject is, until my sentence has been half concluded. This embarrassment may be relieved by a prospective. Availing myself of its aid, I tell you, "It is thought by many France will fight." "It" is obviously not my actual subject, but rather a promise of a subject. Accepting it as such, you realize that what immediately follows must be what I have to say of my subject; and when that saying is ended, you recognize the remainder as my actual subject.

To their inferior prestige, whether used as idea-repeaters or as forerunners, the vicarious words exhibit physical conformity, being weak in bodily presence. By this I mean that they are comparatively small and inconspicuous, thereby making a double practical gain. In "Montgomery says his brother-in-law has sold him his horse," the shortness of the proxies brings me on the one hand quickly to my sentence end and on the other somewhat beguiles your sense of repetition. This double gain is more conspicuous, if the above sentence be compared with the following: "Montgomery says Montgomery's brother-in-law has sold Montgomery Montgomery's brother-in-law's horse."

In the discussion of vicarious usage I have rejected current phraseology, because it tends to offer uncertain and even deceptive suggestions. Grammar, for instance, calls a pronoun's principal its "antecedent."

[1]**This advantage may be compared to that afforded, in the game of twenty questions, by the initial establishment of the unknown object as animal, vegetable or mineral.**

The fact that the so-called *anto*cedent is often really a *post*cedent, is alone sufficiently embarrassing to invite the use of another name. The suggestion offered by the grammatical term is also quite illusive, tending to reverse the prestige of principal and proxy. To call the former the antecedent, that is, the preceder, offers somewhat such a slight as to call the kite the forerunner of its tail or the Sistine Madonna the precursor of its chromolithographic effigy.

Again, the vicarious word is said, like the relative, to "refer" or "relate" to its initiative original. Without emphasizing the fact that the proxy, in its frequent precedence of its principal, strictly *pro*lates, I raise the fundamental objection, that referring and relating give no hint of what in fact linguistically happens. To illustrate, suppose that, having said to me "Brown is ill," you add "He is going abroad," Grammar will have it that "He" "refers" or sends me back to "Brown." But in thought I cannot go backward. The succession of my mental states and activities runs in one direction—forward. It is impossible for me really to return to one of them, when once it has lapsed. My breakfast today may be exactly like my breakfast of yesterday, but in eating it I do not go backward or revert; at most I repeat. So, too, I may think today essentially what I thought yesterday, but I do not really go back even in thought; I do not revert; I merely think again today what I thought the day before. There is, then, no sending backward of the thinker and no going back, of course, on the part of the word.

The presentation of an idea by a vicarious word is a mere incident of symbolism. This incident, of extreme importance to the study of symbols, is unimportant to the study of thought. Whether I say "Brown thinks *he* is ill," or "Brown thinks *Brown* is ill," my thought may be regarded as the same. Concentrating attention now on thought, and in particular on the thought-element illustrated by "he," I note that the idea presented by such a word is used as a thought-factor once when presented initiatively and again when presented vicariously; that is, the idea symbolized by principal and proxy appears in the minds of speaker and hearer twice at least. The following theory of "relatives" consists essentially of the proposition that, so far as an idea be symbolized by merely an "antecedent" and a "relative," that idea is thought but once.

CHAPTER III.—RELATIVE WORDS.

These are described by Grammar as words which relate to an antecedent, that is, to a principal. But, even if such be the fact, it does not sensibly differentiate them from the already examined vicarious words. Like these the relatives are also a linguistic luxury; they assume both retrospective and prospective attitudes; they vary in nearness and fidelity to their principals and in the certainty of their service; they enter the sentence now as one and again as another part of speech. Their principals also vary in number, complexity and thought-factorship, being sometimes single and sometimes multiple, presenting sometimes a single idea and sometimes a plexus, and being at no time confined to appearance as any particular part of speech.

Turning from characteristics shared by relatives with other words, I wish to find a characteristic, if such there be, which distinguishes relatives only. Such, being found, may show whether Grammar is right in ranking relatives as a special pronominal class; whether, to question more deeply, the relatives after all are pronouns; whether indeed they are properly rated even as words.

The following inspection, necessarily somewhat microscopic, I wish to appear as part of a broader survey of mental phenomena, for the sake of making sure, if possible, that nothing indispensable is overlooked. Conceding then to mental activity the greatest fullness conceivable, I offer as my initial topic,

I. MULTIPLE THINKING,

supposing that a mind may work on several lines of thought at once; that two such lines of thought may be parallel, each failing to coincide in any part with the other; that they may be convergent, passing from parallelism to coincidence; that conversely they may be divergent; that two lines of thought, one

more dominant than the other, may converge for a moment and then diverge, the other becoming more dominant than the one; that is, two lines of thought may cross each other, or exchange supremacy.[1]

In normal thought-expression, which is all I wish at present to consider, it is not required to take account of these various forms of multiple thinking. I can tell you and you can successfully listen to one thought only at a time. Even in exchange of thought-supremacy the presenting effort of the moment is single. Written and printed language, being, as thus far developed, mere transliterations of oral speech, are subject to its law, which may therefore be more broadly formulated by saying that, howsoever many thoughts occur together in the speaker's mind, he must present them to the hearer one at a time. That is, simultaneous thoughts must be made successive before linguistic presentation. Attention may therefore be confined to

II. SINGLE THINKING.

It is obvious that in a single series of successive thoughts one member may or may not be linked to its neighbor. That is, single thinking may be

(a) Incoherent.

Thus, given "I just met Brown. Peace is concluded with Spain," it may provisionally be admitted that the two thoughts of this series do not cohere or, in other words, are incoherent.

(b) Coherent.

Given, on the other hand, "I have a book will please you," it may be assumed that the thoughts expressed, namely, "I have a book" and "a book will please you" are coherent.

III. EXPRESSION OF INCOHERENT THOUGHT.

(a) Interrupted.

This mode of expression was followed in "I just met Brown. Peace is concluded." Such expression only is in such a case

[1] Thus in the French "Je crains qu'il ne vienne" a fear that he will and a hope that he will not come may be regarded as exchanging supremacy at "ne." But such change in mid-sentence from fear-expression to hope-expression may be relegated to the special field of sentence pathology.

completely natural. Incoherent thoughts should be expressed by unconnected sentences. Sometimes, however, the expression of incoherent thought is

(b) Continuous.

Thus, "I played, he sang, she danced." This mode of expression, common enough in actual conversational style, is in this case plainly unnatural. My thoughts not being coherent or connected, I should not make my sentences even formally continuous. As neither this nor the preceding case will be found to make use of relatives, both may be neglected.

IV. EXPRESSION OF COHERENT THOUGHT.

(a) Continuous.

This method appears in "I have a book will please you." Such may be regarded as the normal expression of coherent thought; in such the relatives figure; such will form the special object of examination. It is meantime useful to recognize the occurrence of the other method of expression, namely the

(b) Interrupted.

To divide the expression of coherent thought may seem as useless as to make two bites of a single cherry. To say "I have a book" and again "A book will please you", is plainly quite unnatural. That sometimes, however, such a method must be followed, appears as follows:

V. LIMITATIONS OF CONTINUOUS EXPRESSION.

To express continuously an unlimited amount, even of coherent thought, is quite impracticable. Aid to such expression is amply furnished indeed by relatives, as also by tantamount expressions (see p. 104, later), each of which in turn may form the point of attachment for additional relative or similar elements. The linguistic possibilities thus developed are amusingly shown by the nursery phrase-chains introduced by "This is the house that Jack built." Nor are such abuses merely imaginary. I quote from a college daily the following sentence,

which, being part of an obituary notice, may be taken as seriously intended: "The sad ending of the beginning of a life full of promise of all that is held dear in this world, was that of young ——, affectionately liked by his fellow-students and impressing all with whom he came in contact with his sterling qualities of character, modest, unassuming and conservative, dignified and imposing in appearance, yet allowing an air of conviviality and alertness to hover about him, that readily made him a most companionable fellow, an acquaintance to be desired by those who had not the pleasure of his friendship and hospitality, which was always lavish, yet in such good taste as never to be conspicuous." This example proves perhaps too much, indicating the possibility of avoiding sentence-rupture indefinitely. Yet the reader's fatigue may be accepted as showing that bounds have been overstepped. A thread indeed may be spun without a break, as long as spinning mechanism and materials endure. But for the convenience of both seller and buyer it is cut into lengths. So too the mental output, though it might indefinitely continue unbroken, as a matter of linguistic fact, is delivered by installments.

VI. THE BULK OF THOUGHT-INSTALLMENTS.

(a) How Influenced.

Of all the causes which tend to modify the length of the mental message, the most important is no doubt the capacity of the speaker. A successful captain may be a failure, if required to act as general. He who has the linguistic strategy needful to the command of a short sentence, may utterly lack the generalship required for a long one. The capacity of the hearer is also properly consulted by the speaker. The size of a verbal army is conditioned on the ability of the invaded region to support it. With a child the thought-installment must be very small; with an adult it may be greater; with an adult German it may be extremely great.

(b) How Measured.

The individual thought-installment will be found to contain all that this investigation must consider. Since much depends

on the length of such installment, it is desirable to establish a scale by which it can be measured. I therefore invite an effort to determine the proper

VII. UNIT OF THOUGHT-MEASUREMENT.

Suppose that in addressing me you utter merely the phrase "The sun"; and suppose further that you successfully rouse in my mind the idea for which this phrase is commonly used; suppose too that from your utterance I infer that you also are thinking of the same idea. It must still be admitted that the ideal total common to our minds is very meager, too small indeed to be worth your labor in expression or mine in apprehension. The price "for your thoughts" being currently quoted as " a penny," the market value of a single thought-factor can hardly be great enough to warrant the expense of transportation.

Suppose now you go further, saying "The sun, the moon." My mind is now enriched by two ideas, which otherwise I might not enjoy. I may further correctly infer that you also have both in mind. But the market value of your mental output is presumably only doubled. It is safe to say that, were language able only to deal with pairs of ideas, it would not exist in a form deserving the name. Two ideas thus summoned together may, it is true, induce us both to perform upon them mental operations. But nothing assures us that these would be the same or that, even if they were the same, we should be sure that they were so. Such operations, the essentials of thought, are not suggested by the words of my example. These words indeed give only thought-data; and these data alone have not sufficient value to justify expression.

The passage of attention from one idea to another is conveniently known as a mental transit. That you have made such a transit from the idea of the sun to that of the moon, I may of course infer. But my knowledge, even thus augmented, is quite unsatisfactory. I care little to learn that you have merely experienced a succession of ideas, or where the succession began, or where it ended. If anything in such an experience can interest me, it will be the impressions of the mental traveller. You must give me something of the personal element that saturates the "Sentimental Journey."

Suppose now you say "The sun exceeds the moon," or "is behind the moon." You give me now not only two ideas, but also a relation between them; in other words, I know that you have made a mental journey, where it began, where it ended, and, most important of all, your impressions by the way. You reveal in short a complete experience. Such alone is worth the effort of telling and that of learning.[1]

Such an experience, commonly called a thought, consists of two ideas and their relation. Its expression does not always contain a special word for each of its terms. Something is often left to inference. Extra-linguistic aid, for instance that of gesture, is sometimes invoked. The same word even may simultaneously stand for more than one thought-factor. But, however expression be effected, if it be indeed effected, these three elements of thought, a pair of ideas and their relation, all are present. Nothing less will answer. Given "The sun exceeds the moon," if a single term be omitted, the value of the remainder to a receiving mind is essentially nil. Nor will any substitute suffice. "The sun, the comet, the moon" is worthless; so also is "The sun exceeds equals"; the same would be true of any other variation from the combination described as a thought, that namely of two ideas and their relation. Nothing less indeed is attempted by speech.[2] This total then may be recognized as the linguistic minimum and therefore, with special propriety, the linguistic unit. So often then as we find this combination of two ideas and their relation, we tally one upon the thought-score.

VIII. COHERENT UNITS HAVE A COMMON FACTOR.

This truism merely calls for illustration. Suppose I tell you that "I just met Brown—Smith is ill." Measuring by the unit just established, I find two thoughts, namely my meeting with

[1] The question whether thought results imprimis from analysis or from synthesis need not be raised. In any language using words as signs of single ideas (not as signs of whole thoughts) the speaker necessarily analyzes his thought, however first conceived, into ideas. These ideas the hearer forms into a thought by synthesis.

[2] I overlook interjectional utterance, the more or less unmodified survival of the purely reflex cry, originally a mere leakage of the expressional mechanism, void of that purpose essential to the genuinely linguistic act.

Brown and the illness of Smith. These are plainly incoherent; or, in popular parlance, they have nothing to do with each other; that is, they have nothing in common; that is, again, no element of one is also an element of the other.

Suppose, however, I say "I have a book you will like." My total thought again consists of two units, first my possession of the book, second your liking the book. But this time one element is indispensable to each thought, namely "the book." That is, the two thought-units have a common factor. This community is plainly the condition of their coherence. It seems indeed entirely safe to generalize as follows: If two units have a common factor, an element, that is, which is indispensable to or inseparable from each, they cohere.

As the common factor is the key to relative usage, it is well to distinguish sharply between strictly common and merely equivalent factors. In doing so it is convenient, however, to accept a usage which indiscriminately ranks them both as common factors and, using this phrase with admitted inaccuracy, to re-differentiate them as common factor varieties. Of these I take up first

IX. THE SUCCESSIVE OR TWICE THOUGHT COMMON FACTOR.

The common factor of this type occurs when coherent thought is, in its expression, interrupted. Thus "I have a book will please you," expresses a coherent thought continuously expressed. The expression of this thought may however be interrupted, as in "I have a book. The book will please you." In this expression, so soon as I have finished saying "I have a book", all ideas mentioned withdraw from your immediate attention. None of them will reappear without a special invitation—that is, if you be a faithful listener. Wishing you now to think of one of them as factor also of a second thought, I must recall it to your attention. Accordingly I continue with "The book will please you". The idea named by "book" appears, then, twice in your mind, once as a factor of each thought presented. That is, it is a twice-thought factor. It is merely speaking from a different point of view to say that this idea appears later on the

second occasion than on the first. That is, it is a successive factor.

The same is true if I substitute a reinstative for "book" in its second usage. "I have a book. It will please you" differs from my last expression merely in a minor incident of symbolization.[1] Thought is the same. Generalizing on this example, I venture the proposition, that the special office of reinstatives is the formal restoration of thought-coherence, when that coherence is formally broken by the interruption of expression.

X. THE SIMULTANEOUS OR ONCE THOUGHT COMMON FACTOR.

The sentence "I have a book will please you" plainly contains two thoughts, expressible by "I have a book" and "Book will please you." It also is plain that the idea named by "book" is a member of each of these thoughts. It seems to me also plain that this idea, although a factor of two thoughts, is conceived by the mind but once. I claim, that is (what many minds may rank as self-evident) that a single idea is in two simultaneous thought-memberships.

That such a claim is not inherently absurd is shown by its validity even in the most trying application, namely to objects in space. Thus, the northeast corner-stone of my house is at the same time a member of the north wall and of the east wall. The validity of such a claim in the structure of thought may be tested as follows: If the idea named by "book" in my example be twice (or more) conceived, it is plain that its double conception may occur either with "I have" or with "will please you"; or it may be once conceived with "I have" and again with "will please you."[2]

Suppose then first that I doubly conceive the book in connection with "I have," expressing myself by the words "I have the book (1) book

[1] It may be noted that "It" even more certainly indicates the particular book of the preceding sentence than a repetition of "book" itself.

[2] In examining these cases let it be understood at the outset that the question is one of facts and not of possibilities. That the simultaneous factor or indeed any other idea *can* be thought of twice or even more, if the mind be so disposed, must be admitted. Such repetition I will, for the sake of illustration, perpetrate, announcing frankly each appearance of the idea, by a separate use of its word. Accordingly "I I I I I have a book." Such sentences, however, I do not in actual practice employ. Just as at a dinner I do not offer you course after course of soup or oysters, so the mental banquet to which speech invites you is *not likely* to be of the type illustrated. nor of the type "I have have have have a book" nor of the type "I have the book book book."

(2)." In this expression it is plain that book (2) must be in relation with some other element of my thought or else out of relation with each, that is, irrelevant. If it be irrelevant, it has nothing to do with my thought and requires no consideration. If it be related, it must be with book (1) and in the relation of identity; otherwise there is no repetition. Letting this relation be roughly expressed by "is," and expressing thought in full, I obtain "I have the book (1) is the book (2)". But this sentence itself is the expression of two thoughts with a common factor, namely "I have the book (1)" and "Book (1) is book (2)." That is, the present expression is precisely analogous to "I have a book will please you", itself divisible into "I have a book" and "Book will please you." The same result would be reached by a double conception of book with "will please you." I may as well then dismiss these cases and center attention at once on "I have a book will please you."

In this sentence suppose then that "book" is thought of once with "I have" and again with "will please you." Tabulating the total I obtain "I have the book (1) book (2) will please you." In this total it is more necessary even than in the preceding case to find a relation between some term of one thought and a term of the other. For, if none such be found, it is plain that one thought has nothing to do with the other, a status which absolutely violates my conscious purpose. Also there is no relation except between book (1) and book (2); and their relation must again be that of identity. Otherwise the two thoughts are after all concerned with different books; that is, on the one hand the thoughts have still nothing to do with each other and on the other hand there is no repetition.

If there be then repetition, there must be an identity of book (1) and book (2). The thought total may therefore be represented, with the aid again of "is", as follows: "I have a book (1) is a book (2) will please you."

If, however, I adopt the policy of repetition, consistency requires me to go further. Book (1) should be thought of once in "I have a book (1)" and again in "Book (1) is a book (2)". Also book (2) should be thought once in "Book (1) is a book (2)" and again in "Book (2) will please you." Relations being supplied as before, my thought in full would be "I have a book (1) is a book (1) is a book (2) is a book (2) will please you." This, however, is the merest beginning. Each idea named by the word "book" is still a common factor, inviting double thinking as before, with still further expansions as its corollary. Were I to respond to all such invitations, my thought would take the form "I have a book (1) is a book (2) is a book (3) is a book (n)." That is, my imaginary library would overwhelm me; my thought would never be completed. It seems accordingly rational to assume that, in some cases at least the common factor of two thoughts is

not repeated; that is, it is single; that is, its functions or memberships are simultaneous.

Such usage is extremely extensive, being, in fact, by no means a sentential exception, but rather the rule. For thought, in the elementary form of two ideas and their relation, is comparatively rare. In most thoughts one or more of these elements is modified, that is, attended by an adjunct, the modified element being the simultaneous factor of two thoughts. Thus, in "I have a new book" the elements "I" and "book" are plainly in the relation say of owner to property, indicated by "have." But certainly "book" and "new" are also in some relation. For, if not in relation, they are out of relation; and this is but another way of saying that "new" is irrelevant to "book" or has nothing to do therewith. Now as "new" has surely nothing to do with "I" or with "have" or with their combination, it has nothing to do with the thought in which it appears. But this conclusion is obviously untrue. It must therefore be conceded that "new" is in some relation to "book." Whether such relation be indicated by the speaker and, if so, how, is for the moment unimportant. It must be in the thought of speaker and hearer, sub-consciously perhaps, but as an indispensable factor of the mental total. "Book" then is a factor both of "I have a book" and of another thought which might be asserted by "The book is new."

The singleness of the common factor is in this case more evident. So far as introspection may be trusted I feel sure that, in saying "I have a new book", I do not think of the book once as "had" and again as "new." I should also credit you with a most plodding intellectual gait, if I assumed that you were obliged in such fashion to follow my linguistic lead. I do not doubt that you can in fact perform more difficult feats. If I ask you to "bring me a fresh, long-stemmed, red, Japanese rose," I assume that your mind is able to associate the "rose" with "bring," with "fresh," with "long-stemmed," with "red,"' and with "Japanese,"—and all this without separately conceiving the rose in each association. In fact I should almost as soon expect you to bring me five roses.

Were the common factor in such cases doubly thought, the purpose of adjunctive usage would often be imperiled. Thus, in "Ripe apples are wholesome," the purpose of the adjunctive "Ripe" is to restrict your attention to a particular class of apples, alone conceived as wholesome. That is, I do not want you to think, in this connection, of apples that are decayed or immature. Now, my only safety lies in your using my idea in its restricted scope at once. If you let it lapse in the least from your attention, I do not know in what shape it will reappear. That it may come on to the mental stage the second time in greatly modified shape, has been shown in examining the fidelity of reinstatives. To illustrate again, "The carefully selected *apples* of

my orchard were barreled with *those* of the neighboring farmers." I have in this sentence used, to be sure, not the reinstative, but the much more immediate coinstative. But obviously the apples suggested by "those" may be a very indiscriminate lot. The restrictive force of my epithet "carefully selected" has been dissipated. It appears then, that if I wish to subject an idea used in one environment to the restriction of another environment, I must, to be sure of my purpose, put the idea in both environments at once. If I dress up an idea for a verbal party and then let it loose to play with chance companions, I may hardly hope that, when the party begins, my idea will be presentable. It is safer to extend the cares of the dressing-room upon the scene of the party itself. That is, the common factor is made simultaneous.

It is obviously with simultaneous factors that relatives are employed, as in the form, "I have a book which will please you." Two symbols, being however associated with the same idea, Grammar makes the facile assumption that the idea is twice thought. To prepare the way for showing what actually happens I take up next the

XI. DOUBLE FUNCTION OF THE SIMULTANEOUS FACTOR.

Though thought but once, the simultaneous factor has a mission, a part to play, in each of the thoughts of which it is a member; and this part is what I mean by its function. Thus, in "I have a book you will like," "book" is at the same time last term in "I have a book" and in "you will like a book." In "Here is a book will please you," "book" is first term in either thought. In "I have a book will please you," "book" is last term in one thought and first term in the other, or, in grammatical parlance, object in one case and subject in the other.

The embarrassment likely to arise, when the two functions of the simultaneous factor are not the same, suggests some comment on

XII. THE CONVENIENCE OF INDICATING FUNCTION.

This is considerable, even when function is single. To illustrate, using the poetical order, to avoid the hints afforded by usual order, suppose I say that "George the dragon slew." You cannot be sure whether George slew the dragon or the dragon slew George, unless you have some means of information

other than my statement. If, however, some sign were added to "George" or "the dragon" or both, by which you could know what place the idea named by each should occupy in the structure of thought, your knowledge would be complete.

XIII. FUNCTION INDICATION BY INFLECTION.

This it is most convenient to illustrate first in the case of single function. Thus, suppose I tell you that "Universities teach." Into this valuable thought I wish to inject the idea expressed by "thorough." Realizing your need of knowing what to do with this idea, and abrogating, as before, the aid of order, I guide you by the termination of the idea's symbol. If I wish you to use the idea as an adjunct of teaching, to conceive, that is, that the teaching is thorough, I add to my symbol the ending "ly," obtaining "Universities thoroughly teach." If the idea is to be an adjunct of "universities," I let the word remain without a termination and say that "Universities thorough teach." If I wish the idea to appear as a term, I use the ending "ness" and tell you that "Universities thoroughness teach."[1]

The indication afforded by inflection may be even more precise. In "Lunam sol excedit" the inflection "am" exhibits not merely gender and number, but also the use of "Lunam" as last term of thought; at the same time "sol" is by its ending announced as first term. That is, whatever be the order of actual mention, to build my ideas into the intended whole, it is necessary to begin with the sun and end with the moon. For if you begin with the moon and end with the sun, you will need an entirely different relation, not that of superior to inferior, but that of inferior to superior; not that expressed by "excedit," but that expressed by "exceditur."

Whatever else be expressed by such inflections may for the present be overlooked, special attention being concentrated on the momentarily important fact that inflections can and sometimes do announce the function of the inflected idea. The bearing of this fact on the interpretation of relatives can best be seen in the light of

[1] On the incompleteness and the imperfection of this method I do not stop to insist, or to justify the merely convenient use of the word inflection to include all kinds of word-variation, those even usually ranked as derivative.

XIV. THE HISTORY OF INFLECTIONS.

It is the accepted doctrine of philology that these are the mere debris of words at one time in every way complete, originally used as the symbols of thought elements. In illustration it is best to make use of sentences containing verbs of action, these being for many reasons the most frequent. Of these, too, those known as active or transitive are the most striking, dealing as they do with an action of which not only the source, but also the effects are regarded. With the active verb it is also conspicuously important to know which of its attendant terms is point of thought-departure or subject and which is point of arrival or object. Indeed, it is a priori probable that any scheme for announcing a so-called subject (actor) or object (actee) as such, would originate with the active verb, the verb, that is, with which, both being employed, the distinction between the two is of special importance. To illustrate, suppose that a phenomenon occurs describable by the statement "A strikes (ferit) B." Suppose it further uncertain, from this form of statement, whether the striking is done by A or B. Note also that the relation expressed by "ferit" is that between a striker and one struck, between an actor and, say, an actee; for the reverse relation between one struck and a striker would be expressed by "feritur." Given, then, the relation named by "ferit," if you are to construct a thought like mine you must put "A" as first term and "B" as last. If you should reverse the process, you would form a thought conspicuously different from my own.

To avoid such an error, suppose I characterize "A" as an active person and "B" as inactive. From such general characterization you infer that in this particular case also "A" is active or the actor, and "B" inactive or the actee. If, now, "A" be actor, he must appear as first term, in order to fit the relation named by "ferit," that of actor to actee. For I cannot, by thinking say from actee to actor, obtain the relation of actor to actee, any more than I can obtain the sensation of descent by climbing from a low point to a higher. Accordingly the designation of "A" as active shows the function of "A" in thought construction.

As a matter of historical fact a subject sign was so developed. A word meaning active was used with the subject of the active verb. Activity being, however, but an indirect and probably subconscious means for suggesting subjectivity or use as first term, the original meaning was lost; and the word at one time meaning "active" came to mean "used as subject."[1]

At the outset, no doubt, "activity" was used as an actual part of the speaker's thought; but "subjectivity" regarded merely the putting together of thought factors. The value of the word for "activity" sank accordingly from the structural to the instructional rank, from that of a sign of meaning to that of a sign of function. Morphologically speaking, it was "emptied of its meaning," or became "an empty word," that is, in the present case, a function-sign.

Now the number of such signs is in linguistic practice small. Each may therefore reduce its acoustic bulk or shrink in volume, becoming even a single letter, without material danger of confusion with its fellows. Such a sign, moreover, would naturally stand beside the name of the idea whose place in thought-structure it determines. Naturally, also, the order of the two would be, first, the name of the idea; second, the sign of what to do with it. These two, again, the idea and what to do with it, marking a single stage of expressional progress, would naturally combine in a single sentence-member or word. Such, in fact, is the history of an Indo-European subject-sign, the "s" ending of the nominative case, first a separate word naming an idea or thought-element, later the indication of another idea's function, afterward reduced in volume, at last united to the name of the subject-idea.[2]

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[1] That such is the fact appears conspicuously when the subject-sign is used with the eminently inactive subject of the passive voice.

[2] That this same 's' may also have the idea-naming value of singular number and masculine gender, is no derogation to its value as a function-sign; it is a mere illustration of what may be known at pleasure as linguistic economy or linguistic poverty. Separate inflections might uniformly have been used for number, gender and case; but as a matter of fact they were not.

It is noteworthy also that the nominative and the subjective categories do not exactly coincide, as appears in the occasional use of the last term or predicate in the nominative, that is, the case peculiarly appropriate to a subject or first-term case. The grounds of this inconsistency do not here require examination, attention being invited merely to the general fact that language does possess a method, somewhat clumsy, very inconsistent and quite incomplete, yet an available method for distinguishing idea-function.

Generalizing on the offered illustration, I note two central facts in the history of functional inflection: (1) function-signs or inflections have lost original ideal value; (2) function-signs have generally lost original isolation. In the light of these facts it is worthy of note that (3) some function-signs retain their isolation.

XV. ISOLATED INFLECTIONS.

To illustrate these, observe in the first place that in "He urged me *to* eat" the word "to" may be taken with ordinary prepositional value. I may indeed, without change of value, substitute "He urged me *toward* eating," building ideas together by the same plan as in "He pushed me toward the table." When now, in a large number of similar cases, the preposition has thus been employed with a verbal idea in substantive usage, the preposition comes to create an expectation of such usage; that is, it becomes a sign that a verbal idea enters structure as a noun. At the same time its prepositional meaning may disappear, as happens in "He ceased *to* eat;" for a statement retaining such meaning, say "He ceased *toward* eating" is hardly tenable. That is, the meaning of the preposition forms no part of my thought. "To," in short, like "zu," "à," "de," etc., has become an "empty word;" it stands for no thought-element; it is the mere sign of the substantive function of a word commonly verbal only—a function clumsily called infinitive. "To," in other words, is, broadly speaking, an inflection. Yet it maintains its isolation.

Further illustrations of isolated inflection abound; and much more might be said of the field, the aims, the nature and the methods of function-indication. I have however noted what seems indispensable to the immediate purpose of guiding the student of relatives. I therefore pass at once to the special occasion for relative usage, which may be sought in

XVI. THE INDICATION OF DOUBLE FUNCTION.

In section XII. it was observed that function, even when single, may be difficult of apprehension. When now the function of an idea is double—when, that is, it is at the same time member

of two thoughts—the chance of misunderstanding function is naturally multiplied. To illustrate, abrogating as before the aid of order, "The man the dragon slew the lion wounded." From this statement you do not even learn which factor is simultaneous. Assuming this however to be the dragon, I note that, in "The man the dragon slew" you do not know whether "man" or "dragon" was the victim; and, in "dragon the lion wounded," you do not know whether "lion" or "dragon" did the wounding. Clearly then, whatever language does in the way of indicating function, is specially desirable, when function is double. Once committed to the policy of function-indication, language may be expected to attempt such indication in the case in which it is most of all needed. Obviously, too, such an attempt will fail of complete results, unless it indicates each function of the doubly functionating idea.

That the indication of each function is actually felt to be important, appears in the following examples. In Bulwer's Rienzi 2, 1 (so Maetzner), occurs the phrase (1) "defense against *who*soever shall aspire." In the same volume, 2, 6, the same author writes "control of whomsoever should be elected." The structure of these phrases being the same, I substitute in the latter, for greater ease of comparison, the ideas of the former, obtaining (2) "defense against *whom*soever shall aspire." It is obvious that, in (1) and (2) alike, some one (or any one) is conceived at the same time as the object in a defense, and the subject in an aspiration. In (1) the subjective aspect of this some one is indicated by the form "who," the behavior of "whosoever" toward "shall aspire" being irreproachable. But "whosoever" is guilty of ignoring the claims of "defense against," which requires the form "whomsoever." Per contra in (2) the objective aspect of the some one is indicated by "whom," the conduct of "whomsoever" toward "defense against" being quite beyond reproach. But "whomsoever" utterly neglects its duty toward "shall aspire," which requires the form "whosoever." That is, collectively stated, the cited author recognizes the need of indicating each function of a some one, although he fails to meet both needs at once.

The actual method by which these needs are commonly met, though transparently simple, is so obscured by grammatical

misconception, that it can hardly be examined to advantage till the mind is freed, so far as may be, from existing preconceptions. Digressing therefore from the actual method, I offer, as a help to breadth and clearness of view, a brief examination of a priori possibilities. Such examination will reveal a consistent method of indicating double function—one the more worthy of note, that the actual method will be found to be its merely formal adaptation—a method which may be designated as

(a) The Consistent Method.

It has already been observed that the function of an idea in one thought is indicated by one inflection. The functions of an idea in two thoughts would self-suggestively be met by two inflections. The simultaneous thought-factor would be inflected once to indicate its function in one thought, and again to indicate its function in the other.

In some languages, notably in Greek, inflections are applied, as is the case with a part of the tense-signs, to the word's beginning. More commonly inflections appear at the end. When now an idea is simultaneous factor of two thoughts, an earlier and a later, it would be distinctly proper to exhibit function in the earlier thought by an inflection of the earlier part of the idea-symbol or word, and to show function in later thought by inflection of the latter part of the word.

Remembering that the merest possibilities are in consideration, suppose I have in mind a thought expressible by "The Bible teaches whosoever (or any one or the man) wishes to learn." The idea expressed by "whosoever," "any one" or "man" is at the same time last term or object in "The Bible teaches the man," and first term or subject in "the man wishes to learn."

Wishing now in illustration the aid of a very distinct inflectional system, I put my example into somewhat imaginary Latin. Let then the idea named by "man" be expressed by "hom." Inflecting my new symbol in its earlier part, to indicate objective function in the earlier thought, I obtain "Biblia docent nem-hom." Inflecting the word again in its later part, to indicate subjective function in the later thought, I obtain "hom-o vult discere." In combining the two sections of my to-

tal thought, I remember that, as argued, the idea named by "man" is thought but once. Accordingly I use the symbol "hom" but once, obtaining "Biblia docent nem-hom-o vult discere." In this expression the imaginary "nem-hom-o" behaves itself with perfect propriety in both its memberships. It performs its duty to "docent," without in the least neglecting what it owes to "vult."

To make my example even more suggestive, I will slightly change its form. Recalling the fact that function-signs were at one time independent words, entitled to be written separately, I restore the "o" to its ancient rights, obtaining "Docent nem-hom o vult discere." Noting also that noun-inflections, whether showing function in preceding or following thought, affect the terminal position, I conform to custom by changing my illustration into "Docent hominem o vult discere."

In fact it is in such a form that the effort to indicate double function would be expected to find expression. For language, so far as I have learned, has not conceived the expedient of uniting to one word two functional inflections. Such being the case, whichever need of showing function is sooner felt, is met by the use of a single inflection, which is suffixed to the idea-sign or word. The function-indicating power of the word is then conceived to be exhausted. When now the need of showing another function is also felt, and the sign of that function, being made ready, seeks to join itself also to the word, it finds its natural place pre-empted. What would consistently appear as part of the word remains therefore, so to speak, a verbal outsider.

This accident however does not seem to imply any change of values. "Nem" as appearing in "hominem" is still a mere sign that "hom" is to be taken as object of "docent." "O" as before, though now separately written, is merely a sign that "hom" is also subject of "vult." "O" then, although at present separately written, is still a mere inflection of "hom." Also, what is most of all important, the idea named and functionally twice described by "hominem o" is necessarily no more twice thought than was the case with the mentally equivalent "nem-hom-o."

(b) The Actual or Relative Method.

To conform to linguistic fashion, I offer one more improvement in my illustration, obtaining "Docent hominem qui vult discere." Although this change is formally somewhat striking, I claim that in values there is no change whatever. As I read my own thought and expressional purpose, the idea named by "hom" is still conceived but once; its objective function with "docent" is still shown by "nem;" its subjective function with "vult" continues to be shown by "qui." Generalizing on the value of "qui," as thus interpreted, I reach the following propositions: The relative is a function sign. It differs from other function-signs in the fact that, while such others become parts of the idea-sign or word, that is, inflections, the relative maintains its formal separateness or isolation. Also the relative is employed only when it is desirable to indicate two functions of a simultaneous thought-factor. In such case one function is indicated by an ordinary inflection. To indicate the other is the special duty of the relative. Accordingly the relative is merely a specialized and isolated function-sign.

To illustrate more objectively the situation met by the relative, conceive a wedding ceremony and a funeral service to occur simultaneously and so near together, that a woman present may be regarded as forming part of the group attending each. Thus situated she may cherish the laudable wish to conform her dress to each of her two environments. She is in somewhat the predicament of a simultaneous sentence factor, which might advantageously also suit itself to each of two verbal companies. A harlequin costume, partly festal and partly funereal, is forbidden by accepted usage. Could she, however, duplicate herself in form, while remaining personally one; could she in short make use of a dummy; or could she, in theosophic parlance, project alongside of herself an astral body or fictitious self; this illusory second self she might harmonize in dress with one environment, while her real and primary self conformed to the other. That is, without repetition of her actual self, her individual significance, or say her meaning, she might be in formal accordance with her two surroundings. So too of the relative pronoun it may, very figuratively, be said that it is the verbal dummy, on which we hang the drapery of inflections suitable to a second verbal environment.

That the action of the relative word is analogous is suggested by some uses of the definite article. Remembering that the article is

in some languages unemployed, we are prepared to believe that even when employed it may, so far as meaning is concerned, be quite superfluous. Thus in "Er hat den Himmel erreicht," I am unable to associate any suitable idea with "den." It does not distinguish the Heaven considered from other possible Heavens nor add to the idea of Heaven any other idea. It does, however, as admitted by a recent German grammar, serve and serve only to indicate that Himmel is last term or say the object. That is, it is an isolated accusative inflection. On the other hand, in "Der Himmel erwartete ihn," "der" is an isolated nominative inflection.

It is further worthy of note that "der" was originally demonstrative. From this value it varied along two lines. On the one hand, weakening in value, it followed the procedure of other languages and came to be ranked as an article; and further weakening, becoming indeed an empty word, it sometimes reached, as shown above, the value of a mere inflection. On the other hand the demonstrative, by sacrificing its initiative power, became vicarious, dropping from the value of an initiative "that" to the value say of a reinstative "that;" also it further sank from the value of "that" (reinstative) to the recognized value of "that" continuative or say "which," and came to be ranked as a "relative."

Seeking to show the significance of these facts by combining my illustrations, I somewhat violate the usual order of German words, obtaining "Er hat erreicht den Himmel der erwartete ihn." In this sentence Himmel names an idea once conceived, the simultaneous factor of two thoughts. The function of "Himmel" in the first thought is admittedly shown by "den;" its function in the second is obviously showu by "der." "Den Himmel der" is then exactly synonymous with "nem hom o." More especially "den Himmel" is equivalent to "nem hom" or "hominem;" and "der" is equivalent to "o." But "der" is a fully developed relative pronoun, recognized as such by Grammar; and "o" is the purely imagined isolated sign of function. By the interpretation of this illustration it appears then anew, that the relative is merely an isolated function sign, a conclusion in this case the more natural, that the same word with the same original value appears in the same sentence to perform the duties vainly differentiated by Grammar as those of case-signs and relative pronouns.

The form "Der" suggests the process by which the relative was developed. To illustrate: Let my thought in the first place be planned for interrupted expression. I may crudely verbalize it as follows: "Er hat erreicht Himmel. Himmel erwartete ihn." Preferring, however, to avoid formal repetition, I substitute for "Himmel" (2) a reinstative, obtaining "Er hat erreicht Himmel. Der (=that, it, or Himmel) erwartete ihn." In this expression "Himmel" initiates an idea; the idea lapses; it is reinstated by "Der." Now "Der" has in fact two values;

one is ideal, reinstating "Himmel;" the other is functional, showing that "Himmel" reinstated is subject of "erwartete." Let now my thought be planned for continued expression; that is, let the idea initiated by "Himmel" not lapse, but remain in mind as a simultaneous factor. This idea is accordingly no longer twice used, once as an original and again as a copy, but once only, as a persistent original. Such being the case, "Der" can no longer have any power to present this idea, which has already appeared, which still remains, and of which no copy can be utilized. There remains only then to "Der" the opportunity for its secondary value, that of showing that "Himmel" is subject of "erwartete." That is, the reinstative, itself an adaptation of the demonstrative (egocentric), being emptied of its meaning, becomes an isolated inflection or relative.

XVII. SUBSIDIARY VALUES OF RELATIVES.

While emphasizing the function-naming value of the relative, I have not meant to suggest the impossibility of co-existent values. The relative, indeed, may be expected to do what is done by other function-signs. These by linguistic economy are often called upon to accomplish multiple aims. The ending of the word "victor," contrasted with that of "victorem," is an obvious sign of nominative function. But this ending, contrasted with that of "victoria," is a sign of meaning, namely agency; and juxtaposed with that of "victrix" it is the sign of another meaning, namely sex. So, too, even in the inflectional poverty of French, the relative may at the same time exhibit function and initiate an idea. Thus in "avoir (ce) à quoi penser" the simultaneous object of "having" and "thinking" is by "quoi" exhibited as a thing; but in "avoir à qui penser" the simultaneous object is revealed as a person. On the other hand "cui," "cujus" and "quo" express initiatively ideas namable by "to," "of" and "from."

The relative also, and very commonly, has an associative value. Thus, in "The tailor made a suit for Miss X is very beautiful," some factor of "The tailor made a suit for Miss X" is obviously also a factor of "is very beautiful." When now I come to indicate that this simultaneous factor is the subject in the latter thought, I find two available function-signs, namely "who" and "which." Of these "who" is used to show the function of persons only and "which" of things. Accordingly if, to indicate function in second thought, I use the word "which," you assume that the idea whose second function I have in mind must be a thing; that is, the simultaneous factor must be "suit." In other words, the simultaneous factor is indicated by the associative value of the relative.

XVIII. DEGRADED RELATIVES.

In feebly inflected languages it often happens that the relative exhibits no power of indicating meaning, association, or any particular function. To illustrate, in "The ship of Mrs. X's husband that you met is lost," some idea is plainly simultaneous factor of two thoughts. But the word "that" is unable to exhibit this idea as certainly either a person or a thing, masculine or feminine; that is, it has no meaning value. It is also unable to show which preceding idea is simultaneous factor; that is, it has no associative value. It also does not show you whether this idea is subject or object of "met;" that is, it has no specific functional value. The question rises, What is the use of "that"?

Overlooking the ambiguity attending the further employment of "that" as sometimes a "conjunction" and sometimes a "demonstrative," suppose that from context and situation it be satisfactorily understood that the word "that" is the object of "met," and "refers" to "ship." Though these important data be as supposed inferred, that is, in no way indicated by "that", some opportunity yet remains for "that" to be of service. In showing this I take as my point of departure the fact that the relative "that" is the habitual sign of a simultaneous factor's function. As such a sign it is the sign also that simultaneous factorship occurs; it serves as a warning that some part of the thought "The ship of Mrs. X's husband is lost" is to be at the same time part of the thought incompletely rendered by "you met;" that is, it shows that an idea, used already amid given surroundings, is to stand its ground while new surroundings gather about it; though ceasing to serve the hearer as a guide, it still does service by putting him on his guard.

XIX. PROMOTED RELATIVES.

By these I mean a number of words which have graduated from an ordinary relative value into one of higher symbolic rank. In following their advancement, I find a favoring influence, I think, indeed, the originating impulse, in the contentiousness of the average mind. To illustrate this, the statement

that A is B, in the absence of any possible antagonism, is at the most but tamely gratifying; but to hold that A is B, against the attack of even a single opposition, is a bait to the controversial impulse; and to defend this proposition against all comers, challenges a knightly instinct in matters of speech as well as in those of the lists.

The antagonistic element cited in connection with a statement is commonly called a concession. From what has been noted above it follows that, when a concession is made, it is rhetorical to make it big. I shall hardly say that "I can thrash Brown, though he is an inch the taller." Better make it a foot, or add to his superiority in height advantage in years, strength, weight, and knowledge of pugilistics. Or better yet, make B's superiority quite indefinite; leave its determination to your imagination; and stimulate that imagination by making the indefiniteness intense. Accordingly, "I can thrash B, though he is taller to any degree whatever." As a matter of fact, when concessions are made, they are as a rule in some way intensified. It now, it be true that concessions are attended by intensification, it holds conversely that to some extent intensification is attended by concession. The door is therefore open for intensification to become the sign that concession is intended. Thus the phrases "for a truth," "indeed" and "forsooth" are obvious intensifiers of reality; as such they have become unmistakable signs of concessive intention. If I start by saying that "My nephew is *forsooth* industrious," you are well aware that I shall continue with something like "He nevertheless is unsuccessful."

These tendencies proved extremely useful in the development of concessive particles. He who first endeavored to express concession must have been considerably puzzled, for however adept he might be in the invention of symbols naturally suggestive of objects, qualities and actions, he could hardly invent a word suggestive *per se* of a relation so subtle as the concessive. The best he could do was what is still done even today. He would name what was conceded and also what held in spite of the concession, leaving the concessive (antagonistic) relation to be inferred.[1] The limitations of inference on the one hand would restrict him to such concessions as might read-

[1] Conf. "He might come at any moment. He would always find a welcome."

ily be taken for such; on the other hand the belligerent impulse noted above would lead him to intensify his concession. The intensifier, once become the habitual attendant of concession, would soon be taken as a hint of its occurrence, and would even become in time the recognized symbol of the concessive relation.

Reviewing in this light the development of an illustrative word originally relative, I note that "He lies (there) where he fell" means that "He lies in the place (which) he fell in," the idea of place, except so far as defined by his fall, being merely indefinite. On the other hand, "He lies wherever he fell" means that "He lies in *any* place (which) he fell in;" that is, the indefiniteness of the place-idea is now intensified. "Wherever he fell he lies" may have exactly the same meaning; but there begins to be felt a suggestion of antagonism between his falling, conceived in any place, and his present lying, somewhat more distinctly conceived as in a place *particular*, though unknown. You presumably take me to mean "In spite of the location of his fall" or "Never mind what place he fell in," "in that place he lies." That is, the word which intensifies the indefiniteness of his fall's location begins to suggest the concession of the fall itself. If now I say "Wherever he fell, he lies here," the concessive suggestion is fully developed. I mean that "In spite of his falling in any place whatever, he lies (not in that place, but) in *this* place."

In fully acquiring the power of hinting a concessive relation between two thoughts, the intensified indefinite renounces its double membership. The obscurer reasons of this fact may be overlooked in favor of the obvious reason that it is not well for a single word to perform at once too many duties. Accordingly, in "Wherever he fell he lies here," it appears that the originally relative "wherever" has abrogated its membership of the statement "here he lies." It is therefore no longer relative, but solely an intensified indefinite adjunctive to "fell." In this capacity, according to the above noted tendency, it is able to hint, at least, at the concessive relation. That is, it suggests that one thought is felt to vainly antagonize another.

As this relation is of a high intellectual order and in linguistic practice extremely important, the means of its indication are nat-

urally perfected. Their development is clearest perhaps in original relatives of manner. Thus "However he lies he doubtless fell" may mean that he fell in any way (which) he lies in. But in "However he struggles he will sink," the case is different. I no longer mean that his sinking will be marked by any peculiarity which characterizes his struggle. I certainly mean that in spite of his struggling he will sink; and the conception of his struggling as of any sort you please is a mere intensifier, agreeable to me as showing the range of antagonism that my final clause will bear, and helpful to you as suggesting the concessive character of my initial clause.

The rhetorical force of concession is augmented when it is preliminarily put in the form of isolated statement, as in "He struggles bravely." In this form the concession has the further force of being vouched for as true. In order now that you may clearly perceive the antagonism between my concessive and my final statement, I reinstate the former in the statement of the latter, thus: "He struggles bravely. However, he will sink." Examining in this expression the whilom relative, I find its value to be as follows: Its original relative power of double thought membership has totally disappeared. Its indefinite and intensive powers are also essentially lost. Per contra its power of hinting at antagonism has become a power of complete symbolization. "However" has all the meaning of "though" (in spite of), as appears in the exact equivalence of "He will sink, though." Again "However," for the more perfect performance of its new duty, has further taken on the power of reinstating a preceding thought. The meaning of my second sentence in full is, accordingly, "In spite of (trotz) his struggling bravely he will sink." That is, from an earlier rank as instructional sign of second thought membership,[1] "however" has attained the rank of a "thought-connective," a word, that is, with the power of reinstating a previous thought, and at the same time naming its relation with a following thought.

[1] Conf. "I don't know how (=the manner in which) ever (become an intensifier of "how's" indefiniteness) it happened."

XX. PSEUDORELATIVES.

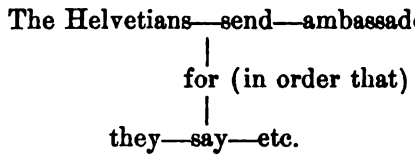
The fact that a linguistic implement was elected to serve a given purpose does not always save it from being put to other uses. In "Is your horse a trotter? He is that," the word "that" is plainly vicarious. In "The horse that I bought is a trotter," it is quite as plainly relative. This change of value is so frequent as to obtain a general recognition. Its converse, overlooked so far as I have noted, may be illustrated as follows: Closing a geometrical demonstration, I say that "A B equals C D, which was to be proven." In this expression "which" informs you that the whole thought embodied in "A B equals C D" is subject of "was to be proven." That is, the simultaneous factor of two thoughts is so extended as to become the whole of the first. Except for this common extension, "which" is a normal relative. I am apt, however, to express myself as follows: "A B equals C D. Quod erat demonstrandum." That is, I force the "quod" or "which" to perform (or perhaps, in view of the history of the word, I should say it continues to perform) the symbolizing office usually assigned to "this" or "that." In other words "which" is in this case not relative at all, but pseudorelative and, in particular, vicarious and of the retrospective type.

Much rarer is the correspondent use of "which" in the anticipative aspect. To illustrate, "Which I rise to remark—and my language is plain—that, for ways that are dark and for tricks that are vain, the heathen Chinee is peculiar." It is indeed possible to construe this sentence as merely inverted and equivalent to "The Chinee is peculiar, which I rise to remark." But abundant similar cases suggest that probably the meaning is rather as follows: "I rise to remark this: the Chinee is peculiar." That is, "which," as above, is vicariously used, but this time in the anticipative aspect.

The reinstative use of the relative seems to be growing in favor. Its very infrequency makes it felt to be a relative out of place, or rather a relative whose place is out. That is, being taken as relative, the hearer feels that it should not be preceded by an expressional break. Thus, having said "This is Miss X" and having let my sentence end, if I continue with "Whom I am

going to marry", you feel that I either ought to have substituted "her" for "Whom" or put my two sentences in one. The predominance of the latter view gives my second statement the aspect of the supplementary, the overlooked, a sort of postscriptal flavor considerably utilized with humorous intention.

The use of the pseudorelative is most remarkable in expressions which exhibit that combination of several ideas under a single symbol, for which I have used the name of multiple symbolization. Such expressions are frequent in Latin, a convenient type being offered by "Helvetii legatos mittunt qui dicerent." In this sentence Grammar interprets "qui" as containing, either by incorporation or inferentially, an "ut." Now "ut" itself, whatever its original value, has come to mean, in such a usage, "for" (in the sense of "pour," "um," etc.); that is, it names the relation which holds between an act and its intended result; in brief it names what may be called a purpose relation and ranks sententially as a preposition.[1] Utilizing this meaning in diagram I obtain



Now, as will appear in the following chapter, if I maintain the connection between upper and lower clauses which is established by "for," I shall not also connect them by making "Caesar" and "he" simultaneous. That is, it is unlinguistic to say "I wrote to Caesar in order that who should come to me." If, therefore, "qui" contains an "ut," either by incorporation or inferentially, it must be that "qui" is not also the sign of simultaneous factorship. This conclusion indeed is endorsed by Grammar, which interprets "qui" as meaning "ut ille" and not at all as meaning "ut qui." That is, the word "qui" is interpreted as uniting with "ut," not indeed a relative element, but rather a demonstrative or, to speak with more exactness, a coinstative. The actually

[1] How far "ut" has also anticipative power, presenting substantively the following thought, with the force originally resident in the phrase "in order that," "for that," or for þy, may be neglected.

present formal "qui" may accordingly be ranked among the merely apparent relatives, that is to say the pseudorelatives.

It should also be remarked that clauses of this nature, being not at all relative, have no claim to that adjective value which belongs to so many clauses genuinely relative. Clauses of the present type are substantive, governed, to use the terminology of Grammar, by the prepositional force of "ut." From the later discussion of relative clauses they may accordingly, for reasons forthcoming, be excluded.

XXI. MISINTERPRETED RELATIVES.

To illustrate these, suppose I say, "It was Brown who gave (me) the book." Whatever might be meant by these words, as a matter of fact I use them to express a thought which may also be rendered by the following words: "The giver of the book was Brown." o fit my example to the expression of this thought it must be construed in violation of several strongly urged grammatical principles. The book-giver is in the first place obscurely heralded by "it," my subject pro tem. This "it," though not ranked by Grammar as an indefinite, is in fact so extremely indefinite that it may stand provisorily, not only for any thing, but also for a person of any gender or number. (Conf. in French "Ce sont mes amies.") This indefinite provisory subject it is which is made definite by the clause "who gave me the book." That is, "who" "refers" to "it."

That, however, "who" is felt by many a speaker to refer to "Brown," I do not deny, admitting rather that in many cases such a feeling is proven. Thus, in "It is I who am the fastest runner," it is plainly "I" that is felt to be the antecedent of "who." For if a verb agrees with its subject in person and number, conversely also when a verb has a given person, it must be because its subject is felt to be of that person. By this law the subject of "am", continued by "who", must be conceived as first personal. Since now the relative and its antecedent deal with the two memberships of a single thought factor, it can hardly be supposed that they would disagree as to the person of that factor. If "who," an obvious relative, regards this factor as of the first person, its antecedent cannot be a word which presents this factor as of another person. By this law "It" is excluded; for it distinctly puts an idea as of the third person. The antecedent therefore can only be "I." The speakers, then, who are responsible for such phraseology, plainly conceived that the simultaneous thought-factor, secondarily described in its function by "who," had been primarily symbolized by "I."

Such a conception is, however, obviously false. In "It was Brown

who gave the book," "Brown" needs no help in showing who is meant. "It," on the other hand, is in need of very much help. Without such help the word "It" is so extremely helpless, that you can hardly suppose I designed to tell you what I meant by the use of a word so impotent. For practical purposes I may quite as well substitute its algebraic synonym and tell you that "x was Brown." Nor does this worthless statement make any important gain in value, when I specify that "x was the book-giving Brown" or "x was Brown-who-gave-the-book." To add to its value, I must put the specification where it will do some good. If I tell you that "x-who-gave-the-book" or the "book-giving-x" or the "book-giving person was Brown," you learn something possibly worth the effort of telling.

The actual structure, better illustrated by "It is I who am the fastest runner," is the presumable result of inattention, occurring also in the following example: "Not a single one of his uncles, his aunts, his nephews or his nieces were there." In the enumeration of my plurals I have simply forgotten that my subject was singular; and for that reason I have used a plural verb. In "It is I who am," etc., the nearer "I" has come between me and the remoter "It;" and I have the more readily overlooked the true dominance of the "It," from the fact that the relative commonly stands immediately after its antecedent. The absurdity of the structure, so carefully indicated by the usual expression, is revealed by the grammatical trick of turning it end for end. "I who am the best runner is (or am) it" does not tell anything that I, for one, feel any impulse to declare. But "I am it (or he) who is (not "am") the fastest runner" announces a claim which I might be induced to enter.

XXII. LATENT RELATIVES.

By these I mean the strictly relative words which Grammar has failed to recognize. To illustrate in crescendo, in "He lay in the place in which he fell," "which" is clearly recognized as relative. In "He lay in the place where he fell," this clearness is hardly diminished, "where" being plainly synonymous with "in which." In "He lay there where he fell," it is further felt that "there" is synonymous with "in the place," the only sign of confused perception being the use of the special designation "correlatives" which seems to isolate the merely pregnant "there" and "where" from the mass of word-pairs employed to exhibit simultaneous factors. In "He lay where he fell," the "where" continues to be felt in its full equivalence to "there, where,"

much as "what" is felt to express by multiple symbolization all the value of "that" and "which."

So far then so good. But, instead of dealing with place, as above, let the simultaneous factor deal with attitude. Accordingly, "He lay in the attitude in which he fell." Substituting as before a somewhat indefinite synonym for "in the attitude," and another for "in which," I obtain "Thus he lay as he fell." This sentence, on the one hand, closely resembles the preceding even in meaning. I have merely substituted the mutual space relation of body members for the space relation of the body itself to other objects. That is, I mean that "He lies in the arrangement, so to speak, in which he fell," instead of "He lies in the location in which he fell." On the other hand, in structure the two sentences are exactly similar. But in "Thus he lies as he fell," I think that Grammar does not distinctly recognize the relative character of any word. Indeed, if I let the "as" express by multiple symbolization all the meaning of "thus as," obtaining "He lies as he fell," the "as" is commonly put by Grammar in the obscure category of conjunctions.

Reserving closer examination of relative procedure for special sections under that caption, I merely claim for the moment that "as," in the present class of cases, is distinctly relative. I believe, indeed, though without exhaustive examination, that all of the so-called correlatives which are employed without an intervening thought-break, will be found to be twin servants of a simultaneous thought-factor, the first member of the pair effecting that thought-factor's initial nomination and the second serving merely to adjust it to a second environment.

In further illustration I note that "A is as great as B" is an obvious equivalent of "A equals B (in magnitude)." The indirectness of the first expression might well excite astonishment, were it not adopted by many cultured peoples. For, my intention being to compare two magnitudes, I strictly ought to say that the greatness of the one is equal to that of the other. But, making a false start, I put it centrally that "A is great." This announcement, futile in itself, I may utilize by developing it into "A is great to the degree to which B is great." Of this expression I propose to show that "A is as great as B" is the exact equivalent.

In the first place the phrases "aussi grand *que*," "so gross

wie," "tam *quam,*" etc., arouse at once the suspicion that the second "as" may be of relative value. Moreover, history reveals the original formula "A is all so (=just so) great. All so great is B." This pair of statements can hardly express a comparison of equality unless the "all so" of the one has the meaning of "all so" in the other. Such meaning is that of some degree not fixed, say "the degree," to distinguish it from other possible degrees. For while this degree is far from definite it is not interchangeable. It is indeed an *x,* but it may not be replaced by a *y.* The meaning then of the original formula is "A is great to the degree. To that (same degree) great is B."

In that formula "all so" is plainly a common factor of two statements, the first "all so" being initiative and the second reinstative. By successive formal reductions each "all so" becomes the modern "as" At the same time the two sentences coalesce, producing (if all elements be retained) the single sentence "A is as great as great is B." This coalescence, it should be noted, entails an important change in thought procedure. My former two installments of thought are condensed into one; and since I may be supposed to conform my plan of thinking, for convenience's sake at least, to my plan of exposition, it may be assumed that my thinking itself is unbroken. That is, the idea of degree is not twice thought, with an intermediate lapse from attention, but once thought only. In other words the idea of degree is now a simultaneous factor. The second "as" can no longer be paraphrased by "to that (same degree)," but must be rendered by "to which (same degree)."[1] Accordingly

"A is as great as great is B" is equivalent to

"A is to the degree great to which great is B."

With a slight inversion the upper expression takes the form of "A is as great as B is great." By ellipsis of terms readily inferred, this form is changed to "A is as great as B—." That such inference occurs in fact, is hinted by the French equivalent "A est aussi grand que B l'est," in which "l" is the obvious equivalent of "grand." Also even in English, whenever the comparison is no longer between degrees of the same attribute,

[1]The change from "demonstrative" to "relative" value is too common to admit of comment.

but between degrees of different attributes, ellipsis fails to occur. Thus, "A is as yellow as B is blue."

In illustration of an even greater linguistic curiosity, suppose that my acquaintance with Brown and my regard for him are both increasing; that, further, the rate of one increase is that of the other. The case is roughly that of two progressions, the ratio of one of which I perceive to equal that of its fellow. In expressing this perception, much more delicate than the one I last considered, I am more likely than ever to make a false start; this I do by stating that "I like Brown increasingly" or "better." This announcement, futile in itself, I may utilize by developing it into "I like Brown better to the degree to which I see him more." Of this expression I propose to show that "I like Brown the more, the more I see him" is an exact equivalent.

Putting history again to the question, I find that "the" (or þy in Anglo-Saxon) means "by thus much," or again, as above, to "a degree."[1] Also in close analogy with the former case, the original expression is presumably this, "I like him the more. The more I see him," which the purest paraphrasing renders into "I like him to a degree more. To that (same degree) more I see him." But the two former sentences have coalesced, producing, if all elements be retained, "I like him the more the more I see him." In this coalescence, also as before, an important change of meaning has occurred. I may no longer paraphrase the second "the" by "to that degree," but only by "to which (same) degree." That is, "I like him the more the more I see him" is equivalent to "I like him to that degree more to which degree more I see him."

Remembering that the relative may be anticipatively used, I interchange my clauses in both expressions, obtaining "The more I see him, I like him the more," and "To which degree more I see him, I like him to that degree more." With another change in the order of the second clause I obtain the conventional form "The more I see him, the more (or the better) I like him.[2]

[1] The difference between the former degree of intensity and the present degree of difference may be overlooked.

[2] In support of the above interpretation I may lay some stress upon its reconciliation of the English formula to the corresponding "je, desto," "d'autant, d'autant" and especially "tanto, quanto."

Of presumable latent relatives the most remarkable, perhaps, appears in the expression "A is greater than B," an expression not merely curious, but also difficult to such a degree, that I venture only to indicate the possibility of applying to its solution the methods thus far utilized. That in this expression a relative element is really hidden, may be suspected from the occurrence of *quam* and its derivatives in the equivalent expressions of Latin and the neo-Latin languages. Moreover history reveals the original value of " than" (Anglo-Saxon þanne) as "that" accusative. Remembering the constant passage of demonstrative into relative values, I feel that the door at least is open to a relative value of "than."

Again in "A is greater than B" it is plain that I do not express myself directly. The direct expression of my thought is obviously "The magnitude of A (not, e. g., its color-intensity) exceeds the magnitude of B." In departing from such directness, I first have overlooked, for the instant, my genuine subject "magnitude (1)," and substituted "A." Continuing my obliquity, I have centrally announced that "A is great." For "greater" expresses the idea of greatness subjected merely to augmentative determination. That is "A is greater," does not mean that A possesses greatness of any type you please, but only of a major type. In other words, the announcement made by my first three words amounts to this, that "A is great to a degree surpassing." This announcement, futile in itself, I may utilize by developing it into "A is great to a degree surpassing that degree to which B is great."[1]

In showing the possible equivalence of this expression to "A is greater than B," I need the aid of a rare expressional method illustrated in τᾶντα ἐχόντως, that is, "the same things havingly." In this, an adverb, derived from a verbal adjective (participle), retains the verbal power of governing an object. In short, there is such a thing as a verbal adverb.[2] Availing myself of this ex-

[1] The somewhat figurative use of "surpassing" is nearly allied to the figure believed to be employed in the Latin ablative, when *quam* is omitted. In the latter case it is felt that the ablative is the point of departure in reckoning, or that the major degree is reached by a withdrawal "from" the minor. In the present case the major is felt to overtake and pass beyond the minor. A difference is in one case figured as a shunning, and in the other as an outstripping.

[2] Even in English the same construction appears in compounds, thus, "She sang ear-splittingly."

pressional implement, I replace the phrase "to a degree surpassing" by its equivalent "surpassingly;" and in doing so I retain for "surpassingly" the object-governing power of its parent form "surpassing." Following then my Greek original, without flinching, I develop "A is great surpassingly that degree to which B is great."

In further approximation to "A is greater than B," let "great surpassingly" be replaced by the essential equivalent "greater;" and let the latter retain, as such equivalent, the governing power of the former. My sentence now becomes "A is greater that degree to which B is great." "Greater," with the meaning "great surpassingly," or "great beyond," should be able to govern "that degree" in the accusative, quite as well as the Latin "major" can manage it in the ablative. Or, from another point of view, "is greater," with the obvious value "exceeds," can take an object quite as well as "schuldig ist" with the value of "owes" can take an object in German.

To bridge the remaining gap, let "that degree" (accusative) be replaced by the historically accusative "than," employed in the sense of "that" (somewhat vaguely suggesting the idea of degree, which is inherent in "greater"). My sentence now becomes "A is greater than to which B is great," meaning "A is great to a degree surpassing that to which B is great." Now just as "that," with possible aid from inference, may stand for "that which" in "Pay me that you owe me," so also with no important stretch of power, "that," or its inflected equivalent "than," may stand for "that to which," especially as, after all, "to which" might possibly be replaced by "which" alone, the common accusative of degree. Accordingly I may change my sentence again, obtaining "A is greater than B is great" with the value, as before, of "A is great surpassingly that degree (to) which B is great." By ellipsis of terms readily inferred, I finally reach the conventional expression "A is greater than B." That the indicated inference of terms is an actual fact is hinted by the French "A est plus grand que B (ne) l'est." Also even in English, whenever the comparison is no longer between degrees of the same attribute, but between degrees of different attributes, all of the thought, as formulated above, is necessarily expressed. Thus, "A is redder than B is blue." This last example also

clearly shows that A and B are not at all compared, nor even their respective qualities, but solely the intensities of these. For it may be assumed that were A and B compared or their respective redness and blueness, the discovered difference would not be expressed in terms of either color. That is, I should hardly tell you that an A is redder than a B which is not red at all, or that the redness of an A is redder than the blueness of a B.

The current interpretation of "than" as "then" I have slighted because it does not appear to be historically defended, because it does not seem to fit the requirements of English context and because it is apparently unavailable with the correspondent expressions of other Indo-European languages. These expressions bear so strongly the marks of original equivalence, that any explanation of a single one is open to suspicion, unless it applies to all. Such general application must, I appreciate, be proven of my own explanation before it can be accepted; and, as I have not the means for a complete verification, this explanation must rank as a pure hypothesis, useless till confirmation except for working purposes, and ultimately, perhaps, at most, as a mere suggestion that existing explanations are inadequate.

Once started in the formation of comparisons, the mind proceeds to astonishing feats. Beginning with separate manifestations of a single quality, it readily notes them, as indicated above, either in their equivalence or in the contrary. It easily also deals with separate manifestations of different qualities, and even compares with ease the rates at which different degrees are acquired. It establishes a norm of quality and compares amounts of deviation therefrom, as in "A's intemperance is as great as (or more so than) that of B." Deviations in opposite directions appear as merely plus and minus aspects of extension in a single dimension. In "A is as tall as B is short" comparison is made between positive and negative departures from a norm. Comparison is even effected between terms essentially incomparable. Beauty and wit can no more be put in comparison, which resembles subtraction of one from the other, than they can be added or multiplied. Yet I shrink not from saying that "He is as handsome as she is witty." If the claim be made that after all it is his departure from a norm of beauty that is compared with her departure from a norm of wit, the difficulty is little relieved. For I have but an imaginary

common unit of measure. I am doing much the same as if I said "This saucer's departure from flatness equals that tardy student's departure from punctuality"; or "It is as spherical as he is late." The results also of comparisons are themselves compared, as in "He is as superior to her as she is superior (or inferior) to her sister;" or "He is as superior to her as she is better than her sister;" or "He is more superior to her than she is superior (or inferior) to her sister;" or, with more confusion, "A is more redder than B, than C is bluer (or less blue) than D." Such comparisons obviously present the merest extensions of the mathematical conception known as proportion. "A:B::C:D" (or A:B=C:D) is a manifest preparer of the way to "A:B> C:D" etc. Also the scope of reality or its imaginary degree is subjected to comparison. Thus, "The more (truly) A equals B, the more (truly) C equals D." Opportunity is thus offered for the occurrence in a single proposition of still further complication. A comparison may be made between the realities of two propositions, each of which compares the results of preceding comparisons. Thus, "The more (truly) A is as much larger than B as C is than D, the more (truly) E is as much larger than F as G is than H." And examples of still greater complexity may be made by comparing degrees of truth and untruth, or of inferiority and superiority, and by substituting irrelevant qualities. Thus, "The more truly A is as much yellower than B as C is less magnetic than D, the less (truly) E is as much broader than F as G is heavier than H."

These illustrations, partly imaginary, I have not formulated with any purpose of reviewing in their wearisome solution the principles already indicated. I note them only as suggesting that, however imperfectly those principles be established, the effort to establish them lies in the right direction; as indicating that something more than the facile relegation of words to "conjunctive" and "relative" categories must be attempted, before the sentence as the picture of thought can be adequately understood.

XXIII. LINGUISTIC RANK OF RELATIVES.

Answering now the question raised in the second paragraph of this chapter, I find that the relative not only lacks the vicarious powers which would give it rank as a pronoun proper, but also is so weak in symbolizing any part of a thought, that it cannot even rank as what is ordinarily meant by a word. To its centrally intended exhibition of a thought-factor's thought-membership it sometimes adds, it is true, the indication of accessory ideas such as gender, number and case relations expressible by prepositions. But even in these bona fide idea-symbolizations it does that only which is done by forms regarded as mere inflections and not at all as words. Barring the accident of formal isolation, the relative is characterized as an idea-namer by nothing which does not characterize the endings of *victoris, victricis* and *victorum*. With these then it should strictly rank. Or if it be insisted that "whose," for instance, contains what is expressed by "of" and that "of" is a word, it may be conceded that the "se" of "whose" is a word, but not the remainder. Apart from such occasional idea-naming, the relative is quite analogous to the isolated infinitive signs *to, zu, à* and *de*. These I should personally not invest with the rank of proper words, *to give, zu geben,* and *à donner* being but so many split synonyms of donare.

XXIV. RELATIVE TERMINOLOGY.

The view of the relative thus far upheld presents it as a mere inflection, distinguished from others by its isolation. These others, which have abrogated their formal independence, may, with some extension of a grammatical figure of speech, be described as leaning upon the words which they inflect, sometimes at the front and sometimes at the rear. They may, that is, be ranked as, in a larger sense, proclitics and enclitics. In contrast to these, the function-signs which maintain their isolation may be known as aclitics or inflections which do not lean.

Again the incorporated inflection is known, according to its place in word-formation, as prefix, infix or suffix. Analogously the isolated sign of an idea's function might be called, when

it precedes the sign of the idea itself, a profix; and when it follows the sign of that idea, it might be called a postfix.

Yet another, and I think a better designation, is suggested by comparison with vicarious words. To illustrate, given "The Bible teaches him who will learn," it is plain that "who" does not indicate that the idea expressed by "him" is to be reinstated (taken up in a second thought after being dropped at the end of a first) or coinstated (duplicated in the same thought before being dropped); the duty of "who" is to show the second function of a factor which has two simultaneous functions. But also, inferentially at least, it tells you more generally that a second function will occur. When now, as usual, the idea in its first function has already been presented, the relative warns you to keep it in mind for further use.[1] It accordingly somewhat resembles the musical sign which directs the musician to hold a given note.

Comparing now it and its linguistic neighbors, I note that the implied order of the reinstative is to recall; that of the coinstative is to repeat; that of the relative is to continue or retain. Such being the procedure of the relative, and its special service being the maintenance of continued expression, it is perhaps most of all convenient to contrast it with reinstative and coinstative by calling it continuative.

[1] Even when such idea, as sometimes happens, is yet to be presented, the relative, showing in the meantime one of its memberships, warns you to look out for the exhibition of a second membership at the same time with the presentation of the idea itself. Thus, in "Who claims me first that man I serve," you obtain from "who" a warning to watch for an idea of which "who" might tell you nothing but the former of two functions. That is, you are warned to maintain an attention which in this case takes the form of expectation instead of the common form of retention.

CHAPTER IV. RELATIVE CLAUSES.

I. SENTENCES IN WHICH THEY APPEAR.

Of these, which may in brief be known as relative sentences, I note as more or less axiomatic that,

(a) They must express two or more thought-units.

An expression of one thought-unit, as "Men are happy," affords no opportunity for a relative; but an expression of two thought-units, such for instance as "Men are happy" and "Men are virtuous," permits the use of a relative, as in "Men *who* are virtuous are happy." Also, as the number of units increases, such increase permits the use of several relatives, as in "Men *who* are virtuous enjoy a happiness *that* well repays the pleasures *which* they renounce."

(b) Two units must have a common factor.

To illustrate, "Men are virtuous" and "Angels have wings," being without a common factor, do not admit the formation of a relative sentence. But "Men are virtuous" and "Men are happy," having a factor in common, namely "Men," allow the use of a relative sentence, as above.

(c) Their common factor must be simultaneous, not successive.

Suppose, for instance, I say that "Men are virtuous" and again that "Men (human beings, they) are happy." Obviously I have expressed two thought-units; and these units have a common factor, namely "men." But this factor has been once conceived in "Men are virtuous," has then lapsed from attention, and has again been brought to attention by "Men (2)" or an equivalent, in "Men (human beings, they) are happy." So long as mental operation is of this sort, a relative sentence will not be formed. That is, a reinstated common factor is not available for relative usage.

Again, in "Brown has lost his horse," there are plainly two thought-units, namely "Brown has lost a horse," and what might be more fully expressed by "The horse is Brown's." These units have two common factors, namely "horse" and "Brown." Of these two the common factor "horse" is also simultaneous and would permit, for instance, the relative sentence "Brown has lost the horse which is Brown's (or his)." But as this possibility is not utilized, it need not further be considered. On the other hand, the common factor "Brown" is not simultaneous. It is successive, being twice thought, once in "Brown has lost a horse" and again in what might be more fully expressed by "The horse is (Brown's, his or) of Brown." This factor, however, has not meantime lapsed from attention. In other words the symbol "his" presents the idea of Brown coinstatively. Now I may not say that "Brown has lost *whose* horse." That is, not only a reinstated, but also a coinstated common factor is unavailable for relative usage.

These propositions apply as follows: A given idea must obviously be thought either once only or more than once, say twice. Again, between two thinkings it must either lapse or not lapse. That is, the second thinking, if it occur, must be either reinstative or coinstative. If now in relative usage it can be neither, such idea cannot be thought of more than once; or in other words it is thought once only. If then, as in relative usage (see b) such idea be a common factor, it must be of the simultaneous type, as announced at the head of this section.

Obedience to this law requires an analysis of the relative sentence different from the one adopted by Grammar, which latter may be illustrated as follows: Given "I met Brown, who is ill," Grammar conceives "who is ill" as the relative clause, and the remainder of the sentence as the principal. If the latter be obliterated, Grammar further notes that the residuary "who is ill" is inadequate, observes that "who" is void of meaning, assumes that it ought to have a meaning, believes that it would have a meaning, were "I met Brown" restored, and accordingly claims that the relative clause depends upon the principal in the vital sense of needing it in the interest of its own meaning.

In arguing against this opinion, which quite obscures the truth, I revive in the first place the claim that "who" is the mere sign

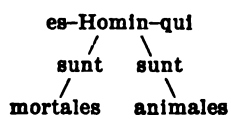
that a simultaneous factor of two clauses is, in the relative clause, the subject; that it has no meaning; that it is not the subject in the relative structure; that the actual subject of the relative clause is "Brown," simultaneously object in the principal. That is, the true analysis is not [I met Brown] (who is ill), but [I met (Brown] who is ill.)

If now one of these clauses be abolished, the question rises, what becomes of their common property? Passing to an extremely objective illustration, suppose that you and I are common owners of a horse. If I am killed, that incident does not destroy the beast or abrogate your ownership. You are no less and it may be even more the owner of the horse than before. Returning to matters of thought, in the phrase "a tall slender tree," I might indeed conceive a tree as once characterized by a pair of qualities. But I may also think of it as twice characterized and each time by a single quality; that is, the tree may be the simultaneous factor of two thoughts. If now I omit the conception of the tree's tallness, I do not find that, in disappearing, it tears from my mind the idea of the tree or even that it makes off with the proper word for that object. That is, given

$$\text{Tree} \begin{cases} \text{characterized by tallness} \\ \text{characterized by slenderness} \end{cases}$$

I do not find that either phrase is mutilated by the disappearance of the other.

In striving to show that the same is true of the strictly relative clause, I wish to avoid multiplicity of issues, such as number and gender. Accordingly let the Latin stem "Homin" stand, in a contemplated illustration, for men; let "es" stand solely for use as subject, or first term, in principal thought; let "qui" stand solely for use as subject in relative thought. In diagramming my illustration, I will write the principal clause downward on the left, and the relative downward on the right. As I shall think of men but once, though in two thoughts, I write the symbol "homin" once only, indicating the sequence of each thought by downward lines. "Qui," as sign of function in the right-hand clause, will naturally stand at the right of "homin." "Es," being sign of function in the clause on the left, I will for convenience write it on the left of "homin." To indicate the functional parity of these signs, I will join each to "homin" by a hyphen. Accordingly



Suppose now I elect to omit the principal thought, namely, that men are mortal, expressed by "Es-Homin sunt mortales." As I have sought to indicate, its disappearance does not involve the loss of the idea named by "homin" or of the symbol "homin" itself. That is, the dropping of the principal clause has not affected any structural element of the relative clause. Far from disappearing, "homin" steadfastly holds its place.

It cannot then be said that "qui" or "who" is left without a meaning. In the first place "who" never had a meaning. In the second place the meaning required by Grammar is present in "homin" or "men," which does not disappear from either my thought or my sentence.

That "men" may be forced to disappear must be conceded. All of my example might no doubt be suppressed except "who are animals." But to such suppression I object as excessive. The severance of the principal, including *its* share in a common subject, is no doubt legitimate. But such amputation, like that proposed by Shylock, must draw no blood. Much more then must it not cut off any member of the relative body. It must leave to the relative clause *its* share of the common subject. Properly then the relative clause consists of "Homin-qui sunt mortales."

It appears accordingly, that the relative clause as well as the principal contain the simultaneous factor. The symbols of all other required meanings it also supplies. It does not therefore depend upon the principal for any part of its meaning. While the relative word is a convenient formal means of recognizing the relative clause, the latter in strict analysis consists of what Grammar calls the antecedent, plus the isolated inflection, plus associated words. Thus in "I met Brown, who is ill," the relative clause is "Brown (who) is ill," "who" being merely the nominative case ending peculiar to the secondary membership of a simultaneous factor.

(*d*) *Two units may have more than one common factor, but one only is made simultaneous.*

Given "A stone struck Brown" and "A stone hurt Brown," I may say that "A stone which struck Brown hurt him," or "A stone struck Brown whom it hurt;" but I may not say that "A stone struck Brown whom which hurt;" and much less may I say "A stone struck Brown yesterday on the shoulder, which hurt whom when where."

It is obvious that a simultaneous factor directly links the wholes of which it is a part. To this proposition it is merely corollary to add that two thoughts, if linked directly each by a simultaneous factor to a third, are indirectly linked each to the other. It is further conceivable

that three thoughts be so constituted that two of them may be linked either directly, each to the other, or indirectly through the medium of the third. Accordingly

(*e*) *Two units may have a factor in common and also, each, a factor common to a third unit. In this case either the factor common to the two or the factors common to the third may be made simultaneous, but not both.*

To illustrate, let three thoughts be diagrammed as follows:

(1) Men — suffer — pain.

(3) { Suffering | is because of | disobedience.

(2) Men — disobey — laws.

Of this trio (1) and (2) have the common factor named by "men." Further, (1) and (3) have the common factor named by "suffer" and "suffering;" also (3) and (2) have the common factor named by "disobedience" and "disobey." As indicated, I may follow either one of two linking processes. On the one hand I may make "suffer" and "suffering" simultaneous, and also "disobedience" and "disobey;" I may at the same time reduce the causal relation of (3) from declarative to merely suggestive form, obtaining "men suffer pain because men (or human beings or they) disobey laws." On the other hand I may make men (1) and men (2) simultaneous, obtaining "Men who disobey laws suffer pain." I may not, however, follow both these methods at once. That is, I may not say that "Men suffer pain because who break laws."[1]

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[1] After linking two thoughts by one of these methods I may, however, again by the other method link one thought to a repetition of the other thought. Thus,

(1)′ Men — disobey — laws.

(2) Men — suffer — pain.

(3) { suffering | is because of | disobedience.

(1)″ Men — disobey — laws.

Let now the "men" of (1)′ and (2) become simultaneous, developing "Men who disobey laws suffer pain." It is practicable further to reduce (2), (3), and (1)″ as before, obtaining in toto "Men who disobey laws suffer pain because men (or human beings or they) disobey laws." It is common in this operation to replace the word "because," etc., by the single word "therefore," which, as I have elsewhere striven to show, is equivalent to "because of that," or, in full, "because men disobey laws." The fact of momentary importance is my ability to use the *reinstative* relation namer, as in "Men who disobey laws, *therefore* (*hence, on that account*), suffer pain." I may not, however, use the *continuative* relation namer; that is, I may not say "Men who disobey laws, *wherefore, whence, on which account*) suffer pain."

The substance of (*d*) and (*e*) may be resumed by saying that when one thought is linked to another, to draw it into the sequence of exposition, a single point of attachment is elected; each car of the mental train is drawn by one coupler. For this fact a psychological reason may be suggested as follows: While I may think two thoughts at the same time, I must, in oral communication and in its thus far current written or printed substitutes, express them in succession. This of course implies their successive appearance in the mind of my hearer. Also my own thinking, under the influence of the successive expressional process, will adopt the successive method. In other words I shall, while speaking, think my thought in the shape in which I mean to tell it; for to tell it in one shape, while thinking it in another, is a feat unduly difficult, if not indeed impossible.

Successive thinking being then adopted, the use of a simultaneous factor implies the holding in my mind of a factor of one thought, during its service as factor of another. This alone is not difficult; but thought-building further implies the apprehension of the factor's structural position in each of two thoughts; and this apprehension of the factor's position implies again some perception of its field or, in other words, the two thoughts of which it is a part. That the mental effort involved is somewhat difficult is indicated by the notorious frequency of error in the use of relative words.[1] This difficulty may be compared to that of looking at the same time after the doings of an Alice and those also of an "Alice in the looking-glass." When now the speaker undertakes the management of two simultaneous factors, direct or indirect, his difficulty may be compared to that of looking at the same time after the doings of two actual and two reflected Alices. Happily such a task is never prescribed. Instead of making each of two common factors simultaneous, instead that is of continuing two factors of one thought into another, the speaker may always drop one or even each of them and pick it up again at his convenience. Thus, declining the effort involved in "A stone struck Brown whom which hurt," I am allowed the less perplexing forms, "A stone struck Brown whom it hurt" or "which hurt him;" and if further indisposed

[1] Conf. "The enemy *whom* he thought would injure him." "The enemy *who* they were sure they had defeated."

to complex cerebration, I may even say "A stone struck Brown. It hurt him." The linguistic law of single simultaneous factor is then but a special application of the general law that energy, in this case mental, tends to follow the line of least resistance.

(*f*) *Of the relative sentence the relative clause may be informational.*

This proposition, being generally admitted, may be merely illustrated as follows: "I have met Brown, who is ill." By this sentence I wish you to understand both that I have met Brown and that Brown is ill. That such is my intention is indicated by my ability, without thwarting that intention, to substitute "I met Brown. Brown (he) is ill." My sentence then contains two statements; or my apparently single sentence is really two. It may be known as *polyphrastic.*

(*g*) *Of the relative sentence the relative clause may be restrictive.*

This proposition merely substitutes the term restrictive for the currently accepted term "determinative," and again requires illustration only. Accordingly, "I want a horse which can trot in 1:30." Applying again my previous tests, I find that if I say "I want a horse. He can trot in 1:30," my intention is defeated. Postponing rigid examination, I confine myself, for the moment, to noting that, in associating a horse with a 1:30 gait, I desire solely to guide you to the mere conception of a particular equine type. I am far from wishing to assert that any horse can trot so fast. My relative clause is accordingly not informational, but restrictive, excluding horses otherwise thinkable. The sentence of which it forms an essential part, containing but a single statement, may be known as *monophrastic.*[1]

[1]The difference between the informational and the restrictive clause may be emphasized as follows: Given the word "men," the idea which it will rouse in your mind is obviously variable. You may think of all men in all that constitutes their manhood—of less—or even of more. The restrictive relative leads you to think of less. Thus, "who are virtuous," excluding "wicked," leads you to think of less men and less qualities. It resembles a numerical coefficient of the fractional type, e. g., $\frac{1}{2}$. On the other hand the informational clause, for instance "who are God's creatures" leads you to think of men in a broadened range of characteristics. Such a clause is, in a sense, augmentive; it resembles a numerical coefficient of the integral type, e. g., 5.

(*h*) *Of the relative sentence the relative clause may be both informational and restrictive.*

Such a clause is merely a peculiar illustration of that economy of speech, which leads the linguistic marksman, when able, to kill two birds with a single stone. To illustrate, suppose that I wish to introduce to you an acquaintance; in doing so I might employ the sentence, "This is Mr. Brown." But suppose again that, knowing several persons of that name, I wish to distinguish this one from others; in doing so I may use the expression "This is the Mr. Brown met by me in London."[2] Suppose also that, never having mentioned this meeting before, I wish to inform you of it; I tell you that "This is the Mr. Brown whom I met in London."

Such usage is comparatively rare; and as it obviously carries with it the peculiarities of both restrictive and informational usage, it may be neglected in favor of these latter pure and simple.

(*i*) *Of the relative sentence the relative clause may be equivocal.*

By this I mean that the hearer may be uncertain whether the relative clause be intended as informational or as restrictive. To illustrate, "The strawberries which were ripe were greatly enjoyed." This sentence may be taken as meaning either "Such strawberries as were ripe (no others) were greatly enjoyed," or "The strawberries (incidentally declared to be ripe) were greatly enjoyed."

An effort has been made to differentiate such clauses by the scope (content or extent) of the simultaneous factor, as it appears in the relative clause. It is indeed obvious that, if the scope of this factor in the relative clause be universal, that clause must be unavailable for restrictive purposes. Thus, strawberries being all of them larger than currants, it would be useless to say, with any restrictive intention, that "The strawberries which were larger than currants were enjoyed." That is, I have no chance to distinguish berries from berries by their superiority to currants. But it by no means follows conversely that, if the simultaneous factor has only partial scope in the relative clause, it is therefore unavailable for purposes of information. To illustrate, "Strawberries, which are very wholesome, are larger than currants." In this sentence "which are wholesome" is plainly informational; to construe it as aiming to indicate what berries are larger than currants would be simply impertinent; it plainly expresses collateral information. Yet in my statement that strawberries are wholesome you must not suppose that I mean them all. I should wish to make a reservation in the case of the unripe and the decayed.

The scope of the simultaneous factor in the principal clause is an equally unsafe guide. It is doubtless true that, if the scope of that factor be universal, I shall not seek to restrict it. But it does not follow that, if it be partial, I must restrict it; for I may even leave it as it

[2] I use the past participle to avoid any appearance of assertion.

is. Thus, in "Strawberries are wholesome," though I do not mean all strawberries, I leave to you entirely the elimination of such as I do not mean. It also does not follow that I cannot use an informational clause. Thus I am likely enough to say that strawberries, which are larger than currants, are very wholesome." That is "strawberries," viewed as wholesome, means certain berries only, the unripe and the decayed being excluded; but "strawberries" viewed as larger than currants may even mean all berries of the species.[1]

The scope then of the simultaneous factor cannot, in either of its functions, settle the question whether the relative clause be restrictive or informational. This is settled purely by the speaker's intention. This intention is usually known from mode (when reliable), context, situation and the other available extra-linguistic aids. When it remains unknown, the relative sentence merely presents a case of that ambiguity with which language abounds. Such ambiguity of the relative clause, comparatively rare and of minor importance, I have noted merely in the effort to avoid oversight, reserving all more careful examination for relative clauses of unequivocal value.

Of these the informational clause, so far as I have observed, presents no difficulties which do not also appear in clauses either principal or restrictive. The last indeed so exceed the first, both in number and degree of difficulties, that I may in the interest of brevity, confine myself in the main to restrictive clauses. As a convenient background on which to project them, I offer a few observations on

II. THE INFORMATIONAL RELATIVE CLAUSE.

The distinctive features of this appear to best advantage, when its services are compared with those of the principal clause. Accordingly, given "I have met Brown, who is ill," it is plain that each of my clauses diligently attends to the business of giving its own contingent of information; and each neither aids nor meddles with the business of the other. The information that I met Brown is not made, in any one of its elements, either more or less clear, certain or comprehensive by the mention of his being ill; and the information that he is ill is quite unaffected by the mention of the meeting. The business of the relative clause is then, when informational, exclusively its own, a fact of multiple significance.

In the first place it is obvious that, of two things one: either a given relative clause is needed to restrict some element of the

[1] My change in the scope of simultaneous factor is hardly flattering to my mental precision, but does not, I think, outdo the practice of average minds.

principal clause or it is not. If now it be not so needed, then and then only is it free to attend to business exclusively its own. In other words the special condition or say the *opportunity* (occasion) of the informational clause is the adequacy of the principal, without its aid.

Looking now from external conditions to conditions inherent in the relative clause itself, I note that, the business of principal clause and that of informational relative, being mutually quite independent, the relative obtains no countenance from the principal. It need not allege activity in the interest of the principal as a raison d'être. Its own business offers ample justification of its existence, without being also the business of the principal. It is not a means to an end but rather an end in itself. In the strongest sense of the word it therefore may be said that the informational clause is self-sufficient. Its warrant, like that of the principal, is the intrinsic value of what it expresses.

This value is primarily dependent on reality. For, if what I tell you be not true, it alone can hardly help you. Yet some leniency must be shown when the informational clause expresses what is not true. Such untruth or unreality may be explained either by deliberate falsification on my part or by self-deception. The former possibility may be dismissed as, strictly speaking, extra-linguistic. That is, it isn't the purpose of speech to express what speakers do not think. As to self-deception, it should be remembered that the purpose of speech is not to express external fact. It aims to embody solely internal or subjective fact, what the speaker thinks he knows, what in other words he believes.[1] Though, as sometimes happens, this belief be not in accordance with external fact, such an incident is the mere misfortune of human weakness, and is again strictly extra-linguistic. So long as I successfully express my

[1] Thus from my assertion that "A equals B" you learn my subjective status only, my belief in the equality of A and B, but by no means the truth of my proposition. Such belief indeed you also learn from sentences not as a rule perceived to be assertive. Thus even the imperative assures the hearer that the speaker desires or commands; that is, it asserts or expresses a belief, not indeed in what is desired, but in the mental state of desiring. Again interrogation, it is true, is a solicitation of knowledge. But it takes the form of information-giving; for it informs the hearer that the speaker desires to be told something. That is, it does not assert that something, nor that telling, but only the mental status of desire, being therefore a pregnant imperative, just as the imperative itself is a pregnant indicative.

belief,[1] I am doing all that the linguistic mechanism was intended to perform. Accordingly an informational clause may be recognized as having primarily the necessary value, if only it expresses what the speaker believes to be true.

This value is secondarily dependent on the hearer's previous ignorance of what the informational clause expresses. As a reasonable person, I shall not waste my breath in telling you what you already know. And passing from my personal viewpoint to that of my hearer, I must perceive that he will not welcome speech which merely reviews for him the items of his knowledge, but only such as augments it. If, knowing you to be aware of Brown's illness, (and also who is meant by Brown), I nevertheless declare that "I have met Brown, *who is ill*," I am guilty of a linguistic impertinence second only to falsehood. Indeed it may be questioned whether a stale truth be not on occasion more offensive than untruth. It must indeed be admitted that I may err in supposing you to be unacquainted with what I tell you; but such an accident may be overlooked. So long as the speaker thinks that he is going to augment the hearer's knowledge the requisite condition is fulfilled.[2]

Overlooking, as unnecessary, the aesthetic, utilitarian and ethical aspects of value, I resume as follows: *the warrant* of the informational clause is the supposed reality and novelty of its import.

As the relative clause of the informational type is active, like the principal, solely in its own interest, it may be said to be egoistic. *Its purpose*, like that of the principal, and like that of an isolated sentence, is to give information of its own.

In tactics the informational and principal clauses offer further

[1] Disbelief, being merely belief in the unreality of what is mentioned, may be included in this stipulation, thus extending its application to negative sentences proper.

[2] The tentative review of facts in argument is merely a form of exposition adopted, in protracted reasoning, for the sake of greater ease and clearness. Thus, assuming you to know that $a=b$ and that $b=c$, but not to have perceived the relation of a and c, I say to you "$a=b$. $b=c$. Therefore $a=c$." Of these announcements the first two may be interpreted as inviting objection to premises, being equivalent to "$a=b$? $b=c$?" Or the whole may be regarded as merely a paraphrase of "Because of a's equality to b and b's equality to c, a is equal to c." Again, while aware that you know the equality of a and b, as well as that of b and c, I may think it likely that you have forgotten these facts or at least are not thinking of them at this moment, that is, that you are in a state of momentary ignorance, in which case the use of informational expressions is justified by their momentary novelty.

agreement. To illustrate, in "I have met the Browns, who are going to Europe" I will suppose that you know perfectly well whom I mean by "the Browns," without the help of anything but the word itself. With the idea which it suggests, by means of suitable words I induce you to associate other ideas, so as to form the thought expressed by "I have met the Browns." Also with the idea expressed by "Browns," by means of other suitable words, I induce you to associate still other ideas, so as to form the thought expressible by "The Browns are going to Europe." This, too, I believe is all that you do, either by my inducement or independently. That is, whether the principal or the informational clause be examined, one form of procedure appears. In particular, then, it may be said that the *procedure* of an informational relative clause is this: by means of terms associated with a term occurring in the principal it formulates a proposition.

As both the principal and the informational clauses aim, as expressions of the speaker's belief, to increase the hearer's knowledge, both are properly put in the form of assertions. Thus, in "I have met Brown, who is going to Europe," there can be, I think, no question that I assert not only my meeting with Brown, but also Brown's going to Europe. Now assertion is the distinctive characteristic of a sentence. (See Note, p. 89.) As a sentence, therefore, the informational relative properly ranks, differing from others merely in the circumstance that one of its factors is simultaneously a factor of another sentence.[1] This circumstance, it is moreover obvious, is characteristic also of its principal.

In the examination of the restrictive clause an effort will be made to show that it enters the principal clause as one of its elements, or in other words as a part of speech. Now the informational clause is not a part of speech at all, but, so to speak, a speech in itself. In other words *the function* of the informational clause is that of a sentence.

The exact opposite, in most cases, of the informational clause in opportunity, warrant, purpose, procedure, and function I plan to exhibit in

[1] Or, in other words, principal and informational clause together form a polyphrastic sentence. See Section I, f.

III. THE RESTRICTIVE RELATIVE CLAUSE.

(1) Its Opportunity.

To illustrate this, if "Men die yearly of cholera" expresses to my satisfaction what I intend, I shall let well-enough alone and use no other words of any sort. But if my statement is inadequate, if for example I further wish you to know what kind of men or how many or which, I am likely to use linguistic means to effect my desire. Of these, which are many, the restrictive relative clause alone is of momentary interest. Of it in particular it may then be noted, that its opportunity is the inadequacy of the principal clause.

(2) Its Warrant.

Supposing such an opportunity to exist, the right or warrant of the restrictive relative to utilize it may be illustrated as follows. Suppose that, meeting you at a social gathering, I wish to tell you that one of its members, a Mr. Brown, is the son of my brother. My natural impulse is to say that "Brown is my nephew." But I recall that you do not know his name. His specific designation being therefore unavailable, the best remaining single word for him is possibly "guest," which at least excludes the host, the family, servants, reporters, and all beings not human. But from this word you cannot learn which one of many persons I intend. Casting about me for a remedy, I note an exchange of salutations between my kinsman and one Smith, at the very moment when your eyes are on the former. I solve at once all difficulties by designating the person I intend as "The guest who bowed to Smith."

In doing so I am not to be understood as attaching special importance to the salutation. Any other distinctive act would have served as well. Thus, overlooking a mere aesthetic preference for the comely, I might with equal clearness say "The guest who stretched his legs" or "The guest who yawned so dangerously is my nephew." But had any other person bowed to Smith or yawned or stretched while Brown was doing the same, I should have neglected each of these acts, for the reason that no one of

them would have served to show you the person of whom I wish to speak.

To generalize, given in a principal clause a need of determination, a particular restrictive clause is admitted only in case it can meet that need. Given also several restrictive clauses able to meet that need, the choice among them is guided first of all by their respective ability. The restrictive clause has no individual raison d'être. It cannot justify its existence by the unaided value of what it mentions. This is not itself an end, but only a means to an end. Far from being like the informational relative self-sufficient, it is in itself conspicuously insufficient; it is merely ancillary or auxiliary; it is dependent in the sense of needing another clause in justification of its own existence. Its warrant for entering the sentence is by no means the intrinsic value of what it expresses, but the availability thereof in the service of the principal.

Such being the case, it is strictly irrelevant to consider at all the question of its intrinsic value. Yet the confusion prevalent at this point is so great as to invite some development of the following axiomatic proposition; the intrinsic value of a restrictive relative may be what it will, either in reality or novelty.

Examining in turn the elements of value already noted on p. 89, I find, in the first place, that the import of the restrictive clause might be either already known or unknown. That the already known should be available in the clarification of a statement has been already shown in "The guest who bowed to Smith is my nephew." In this example I utilize your knowledge of the bowing, to help you understand what guest I mean. The contrast between the restrictive and the informational clause is in this case at a maximum. The latter is a gift added to that of the principal. The restrictive is rather a draft upon your acquisitions to pay the expense of transporting the principal. The informational embodies what you don't know, because you don't know it, and in order that you may know it. The restrictive embodies what you do know, because you know it, and in order to help you know something else.

That the unknown should also be available in restriction is not so obvious. To illustrate, I choose, among many possible cases, the extreme one, in which neither speaker nor hearer knows that which the restrictive mentions, and neither has ever even heard or thought of it before. I assume accordingly that the thought of men's eating rats has never appeared in your mind or mine, and that much less can either of us know that they do so. Wishing now to indicate the gastronomic

fortitude required at our boarding-house, I tell you that "We need the stomachs of men who live on rats;" and this I do with perfect confidence that you will think of such men and thereby of such stomachs as I do myself.

Again, that what is true should offer available aid in the acquisition of truth, is sufficiently illustrated by "The guest who bowed to Smith is my nephew," the salutation being supposed to have occurred. That, however, the acquisition of truth may be aided by untruth, is not so plainly apparent. A complete examination of the different forms of this possibility would lead too far. Contenting myself on that account with a single crucial test, I suppose that my servant has worn to a firemen's ball a pair of trousers, which at the time he believed to be mine. But later he has learned that what he actually wore was the similar garment of a guest who has since departed with all his belongings. To make the illustration even more effective, let it be conceded that I also know this and that each of us is aware of the other's knowledge. Suppose now that I say to my servant, "Bring me the trousers that you wore to the firemen's ball." Bringable trousers including assumably only my own, it is plain that none such can truly be characterized as worn to the ball. Yet I do not hesitate so to characterize the desired pair; and, guided by such characterization, my servant thinks of the right trousers; he wastes no time in psychologizing on the reality, probability, possibility, or plausibility of the characterization; he gets the trousers.

Be then the intrinsic value of the restrictive what it will, it will be used for restrictive purposes, if only it be able to restrict.

(3) Its Purpose.

To illustrate, suppose that, as above, I use the sentence "The guest who bowed to Smith is my nephew;" my motive needs, I think, no demonstration. Recognizing that, without the clause "who bowed to Smith," my contemplated statement would be inadequate, I intend that by the use of this clause such inadequacy be relieved. My motive is even more conspicuous in examples offering a severer test. In "All men who live in England are called English," and again in "I don't know any man who is perfectly happy," the inadequacy of the isolated principal clause becomes untenability. Unless my principal shall absolutely contradict me, I must relieve its inadequacy by a restrictive. The relieving purpose of my relative clause is emphasized on the one hand by glaring need. On the other hand

it is emphasized by the completeness with which it meets that need. The restrictive clause is not, then, used for its own sake, but for the sake of the principal. It is not, like the informational, egoistic; it is altruistic. Its purpose is to aid the informational effort of the principal.

(4) Its Procedure.

In examining this it is convenient to begin with cases in which, to use the words of Grammar,

(a) The relative word is subject of the relative clause.

Let such be illustrated by "The guest who bowed to Smith is my nephew." Reviving the doctrine proposed on p. 60 that the value of "who" is not structural, but only instructional (like that of plans and specifications), and assuming that the instruction offered by "who" has been duly utilized, let attention be confined to structural elements only. Such elements may be presented, and their simultaneous factor indicated, by the diagram,

$$\text{The guest} \begin{cases} \text{—bowed to —Smith (relative)} \\ \text{—is—my nephew (principal)} \end{cases}$$

The psychological reactions attending the presentations of ideas in the above two clauses are by no means alike. In "The guest is my nephew" (principal), since you regard ideas named as mutually suitable to thought-formation, you accept my suggestion to combine them into a thought. On the other hand, in "The guest bowed to Smith" (relative), since you perceive ideas named to be put by me as forming a thought, you infer that they are mutually suitable for thought-formation. That is, in the principal clause, because ideas are mutually suitable, you combine them into a thought; but in the restrictive clause, because ideas are combined into a thought, you accept them as mutually suitable.

To complete my purpose, you must comply with two conditions. In the first place, while conceiving the ideas named by "The guest bowed to Smith" as in a general way mutually suita-

ble, you must in particular conceive the "guest" as suitable to "bowed to Smith;" and this you cannot do of each and every guest. You must not therefore think of any guest who did not perform that act. That is, in order that the idea named by "guest" may suit the ideas named by "bowed to Smith," it must be the idea of only one, and a particular one, of the persons assembled. In the second place, having thought of the right guest in connection with "bowed to Smith," you must hold fast to him, and not allow him to be displaced in your mind, or accompanied by any other, as you pass on to his being my nephew That is, in the relative clause of restrictive type, the simultaneous factor must be conceived suitably to the other ideas with which therein it is associated; and in the principal clause that simultaneous factor must be conceived exactly as in the restrictive. In other words, the scope of the simultaneous factor is, in the relative clause, adjusted to suit its fellows; and in the principal clause this scope is maintained. The simultaneous factor, it may then be said, is specially fitted for its service in the principal clause by its service in the relative clause; and, as this special fitting is a reduction of possible scope, it may very well be said that the simultaneous factor, in its use as part of the principal clause, is restricted, determined, or limited by its associates in the relative clause; or, in particular, "guest" is limited by "bowed to Smith."[1]

In order to feel this limiting, this adaptation of the scope of the relative to its fellow clause-members, the mind is obliged to view the relative clause as made up of a limited and a limiting part—to analyze it, that is, in the present case, into its subject (the simultaneous factor) and its predicate or remainder. "Guest," the true subject of the relative clause, is juxtaposed

[1] By Grammar, however, the limiter of "guest" is said to be "*who* bowed to Smith." The utter untenability of this proposition will appear, I hope, in further examination. For the moment it may be enough to note that if, as I argue, "who" is merely an instructional element, it cannot be recognized as naming one of the ideas restricting "guest," but if, as Grammar will have it, "who" stands for an idea or thought element, that idea can only be that of "guest;" that is, such idea is twice thought of, once as symbolized by "guest," and again as symbolized by "who." But the moment "the guest" is thought of twice, it ceases to be a simultaneous factor, becoming successive; that is,a breach occurs in thought continuity, and the actual value of my sentence becomes "A guest bowed to Smith. The guest is my nephew;" that is, I have no longer a single monophrastic sentence, but two sentences or, at the least, a sentence of the polyphrastic type.

to "bowed to Smith," as predicate. Between the two there is perceived a fellowship, a mutual belonging, a relation of part to part (of a single mental whole), the relation expressed by the so-called copula, as holding between subject and predicate. Now, granted this predicate, plainly the subject, in order to maintain this belonging, must adapt itself to whatever the predicate requires. Conversely, the predicate, forcing the subject to do this, may be regarded as its limiter, determiner, or restricter. Accordingly the ordinary subject-predicate analysis, constantly urged by Grammar and Logic, fits the present case. But the present case is one only of many, with the remainder of which this analysis will not avail. These remaining cases I will bring together under

(b) The relative word is not the subject of the relative clause.

This case presents itself in many varieties, of which I propose to examine a few only of the more conspicuous. To illustrate, "The guest whom Smith saluted is my nephew." In this sentence also I think it undebatable that my purpose in saying "whom Smith saluted," is the same as it was in saying "who bowed to Smith," namely, to confine your attention to a particular guest, although in the present illustration "guest" is no longer subject in the relative clause. The usual analysis, however, no longer meets requirements. If I regard my relative clause as consisting of a subject "Smith" and a predicate "saluted the guest" (here again by no means "whom"), I not only receive no aid, but am actually hindered from seeing the operation of restrictive elements. For the blending of "saluted" and "guest" in a single total precludes that discreteness of "guest" which I require in order to feel its adaptation of itself to its fellows. So also the separation of "Smith" and "saluted" breaks the totality in which I wish to view them as a restricter of "guest." I must plainly conceive the analysis of thought more largely than is customary either in Logic or in Grammar. I advance accordingly these general propositions: A thought may be analyzed into any one of its ideas and the remainder; between that one and the remainder may be conceived that

mutual belonging indicated by the so-called copula; in any such analysis the remaider may force the one idea to maintain this mutual belonging by self-adaptation. That is, to any element of a thought the remainder may be a restrictive predicate; or, in other words, any thought-element may be restricted by the total of its fellows:

In illustration, suppose that a given orange is larger than a given lemon. Were I to analyze my thought historically; were I, that is, to regard the method of its actual development, I might very well find that I had seen first the orange; that I had next observed the lemon; that I had, in passing from the one to the other, been conscious of a difference or relation expressed in "The orange exceeds the lemon." That is, my analysis would develop three factors, an orange, a lemon, and a quantitative relation. But I can, no doubt, re-analyze this thought into a pair of parts related merely as the mutual complements of one whole. In so doing I may elect either of my three original terms as one part and regard the others as its complement, my analyses taking the following forms:

Orange—exceeds lemon.
Exceeds—orange, lemon.
Lemon—orange exceeds.

Also any chosen part may be noted as adapting itself to the requirements of the others. Thus,

The orange must be of such a size that it will exceed the lemon.

The excess must be such that it will suit the lemon and the orange.

The lemon must be of such a size that the orange will exceed it.

In other words, the orange, the excess and the lemon may be successively determined, each by the total of its fellows.

The determination of a relation, say that of excess, by this method is not, to my knowledge, directly accomplished in speech. I may indeed make use of such an expression as "The plum exceeds the cherry *to the degree in which* the orange exceeds the lemon." But I do not use a relation simultaneously as factor of two thoughts, for the purpose of letting the use in one thought fit it for use in the other. That is, I do not use expressions of

the type "The plum exceeds the cherry, *whiches* the orange the lemon." In other words, we have not yet developed relative verbs. Such verbs, being then merely an unrealized possibility, require no consideration. Accordingly the present case (b), in which the relative is not the subject, excludes both the case in which the relative is subject and the case in which it might be the middle term or verb.

Among the varieties of case (b) I take up first the one in which the simultaneous factor appears in the relative clause as its direct object. Reviving the illustration "The guest whom Smith saluted is my nephew," I note that my meaning is as follows: The guest suitable to "Smith saluted" is my nephew. That is, just as with "who bowed to Smith" the simultaneous factor was determined by its fellows "bowed to Smith," so also with "whom Smith saluted" the simultaneous factor is determined by its fellows "Smith saluted."

What holds of the direct object holds also of the indirect. In "The guest to whom Smith bowed," the simultaneous factor "guest" is determined by "to —— Smith bowed." That such is the fact is vividly suggested by the antigrammatical tendency to range all the idea-naming words of the relative clause together, as in "The guest (whom) —— Smith bowed to." The motive for this arrangement seems to be that, the simultaneous factor "guest" being put by itself, and the remainder of the relative clause appearing as an unbroken total, the necessary juxtaposition of such factor and such total is made more easy.

The adjunct of the subject is similarly treated. Thus, in "The dancer, of whom the partner bowed to Smith, is my nephew," "whom" is merely the sign that "dancer," in the second of two simultaneous thought memberships, is governed by "of;" moreover, the prepositional phrase, "of whom," that is, "of the dancer," is in one aspect obviously a restrictive adjunct of "partner;" but, in a momentarily more important aspect, "of —— the partner bowed to Smith" is a restricter of "whom," that is, of "dancer," as suggested again by the popular form "the dancer (whom) the partner of bowed to Smith."

The adjunct of the object forms no exception. In "The dancer of whom Smith saluted the partner," "dancer," in its second membership, forms with "of" an adjunct of "partner,"

the object of the relative clause. But here again it is also and more significantly true, that dancer is restricted by "of —— Smith saluted the partner," as again is strongly hinted by the popular form, "The dancer (whom) Smith saluted the partner of." Indeed, if strict account be kept of the double value of the so-called possessive "whose," an even stranger construction may be developed. For "whose" unquestionably means "of whom" and may, indeed, be analyzed into the elements "who (the mere sign of second membership) and "se" (synonymous with "of"). The merely instructional value of "who" being once noted, it may, in the consideration of thought-elements, be allowed to disappear. Thought-architecture may accordingly be faithfully indicated either by

"The dancer —— (whom) Smith saluted the partner of," or

"The dancer — (who) Smith saluted the partner *se.*" That is, by either notation, the clause beginning with "Smith" is a restricter of "dancer."

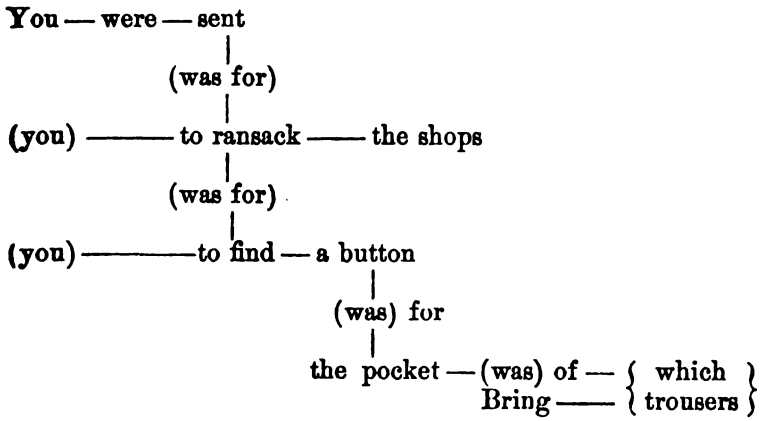
The simultaneous factor may serve in the relative clause as verbal adjunct, or, more strictly, as part thereof. To illustrate, in "This is the place in which Lincoln fell," the prepositional phrase "in which" is grammatically ranked as the adjunct of "fell;" and of this adjunct the relative "which" is a part. But in this example my aim in using the relative clause was to restrict the idea expressed by "place." I wish you to conceive a place distinguished from all others by Lincoln's in-falling. That such indeed is the usual intention is indicated by the popular "This is the place (which) Lincoln fell in," the purely instructional value of "which" being further hinted by its frequent omission.

The structure of thought in such usage is commonly disguised by multiple symbolization, the duties of both "in" and "which" being performed by the single word "where." I may accordingly say, "This is the place where Lincoln fell." In this expression "where" is commonly styled a relative and an adjunct. But strictly speaking, "where" possesses two values, namely, "in" and "which;" and of these one only is relative, while both are required to form an adjunct.

The place-idea may be combined as above with the same relation (e. g. "in") in both clauses; and also each combination

may be expressed by multiple symbolization, as in "A stain of blood remains there (in the place) where (in which) Lincoln fell." In such case the function of the simultaneous factor being in both thoughts the same, the need of indicating it in the relative clause is little felt; accordingly the relative word might be omitted. But at this point confusion arises. In substantive usage of the simultaneous factor it is, as properly, the relative itself that disappears, as in "I have met the man (whom) you seek," etc. But, in the case of a verbal adjunct, what disappears is more commonly the so-called antecedent, as in "A stain of blood remains (there) where Lincoln fell." Whether in such case there be a supplying of "there" or an exchange of meaning between "there" and "where" or an incorporation of both meanings in "where" (Conf. "what" = "that which"), it is needless and possibly useless to inquire.

That the simultaneous factor may appear not only as part of an adjunct in the relative clause, but also as part of an adjunct of an adjunct, and so on to the *n*th degree of remoteness, is an obvious possibility. The actual retirement of this factor into the more distant background of the relative clause may be illustrated as follows: "Bring me the trousers for the pocket of which you were sent to ransack the shops to find a button." That is, in diagram:



Accordingly "trousers," in its membership of the relative clause, is part of an adjunct of "pocket," which is part of an

adjunct of "button," which is part of an adjunct of "ransack," which is part of an adjunct of "sent;" or, roughly speaking, "trousers," in the above membership, is in the fourth degree adjunctive to "sent." That all of this intricate relative clause, except "trousers," is however used as a restricter of "trousers," is indicated by the fact that popular arrangement juxtaposes "trousers" with the gathered troop of its fellows, thus: "Bring me the trousers (which) you were sent to ransack the shops to find a button for the pocket of."

Generalizing on cases examined, I contrast the restrictive clause again with the informational, noting that the procedure of the restrictive clause is this: By means of terms associated with a term occurring in the principal, it occasions an adaptation of that term, in scope, to its associates.

(5) Its Function.

Reviving the substance of (2), I note that the restrictive is a mere auxiliary. It always determines an otherwise inadequate element of the principal clause. It is not in itself a speech, but a "part of speech." What part of speech it is depends in grammatical classification, largely at least, upon what part of speech that element is which it determines. But such elements themselves are classified as parts of speech by conflicting criteria (see p. 2). Also, in the exposition of Grammar, many restrictive uses of the relative clause are overlooked.[1] To state the functions of restrictive clauses in grammatical phraseology, that is, to rank them as parts of speech, is largely, therefore, to arrange what Grammar has not seen by categories which Grammar cannot justify. To be consistent, then, with the grammatical system thus far developed, would be like solving on a larger scale the kill-joy problem: "If a third of six were three, what would a fourth of twenty be?" That is, the extension of the grammatical system must be conformed in error to the parts already developed. From a task so embarrassing and also, I think, so needless, it is perhaps no shame to recoil. Assuming

[1] Thus, in "A government *of* the people in the sense which you employ in 'if the doctrine be *of* God,'" the relative clause is adjunctive to "sense;" and "in the sense" is itself adjunctive to "of" (1); that is, the restrictive clause is adjunctive in the second degree to a proposition.

therefore, that the operation of restrictive clauses has been sufficiently exhibited in the preceding illustrations, I content myself with the following generalizations: The purely restrictive clause is an adjunct, auxiliary to some element of the principal clause; it may, at least in theory, be adjunctive to any such element and in any degree of remoteness; its function is never that of a sentence, but always that of a subordinate sentence-factor; accordingly it does not make a statement.[1]

From what has thus far been noted it appears, as many thinkers indeed have conceded, that whenever thought is extended beyond the minimum of the type "A = B," it must be by the methods followed in forming that minimum. Some element of "A = B," as for instance "B," must appear in relation with some new element, as in "B > C." If the increment is to be felt as structurally one with the original, the common factor of the two, namely B, must be once thought only, or simultaneous.

Now thought, at least as expressed in the language of cultured peoples, exhibits extension as a rule, and usually very many extensions. The venerable propositions, "Men are animals," "John is a man," "John is an animal," are rarely encountered outside of philosophy. It is much more common to meet with statements such as "That smug *John* Smith, who just bowed so deferentially, with all his conciliatory manner, *is a* sly *fox.*" What may be called the minimal sentence is, then, the linguistic exception. In actual practice the sentence is almost always extended; and, as above indicated, extension implies the occurrence of a simultaneous factor.

The problem of the simultaneous factor (which is the problem of the extended sentence) is, accordingly, far more frequent than that of the minimal or elementary sentence. It may indeed be conceded that this is *the* problem of speech. To exhaust this problem, in the present investigation, would require time and effort quite excessive. Yet, the relative clause being only one of many forms in which the simultaneous factor,

[1] It must be admitted, as implied on p. 87, that a given relative clause, while aiming on the one hand to aid the informational effort of another clause, may occasionally be at the same time intended to give information of its own. Such a clause, though restrictive, will be asserted because also informational. On p. 110 will be found some indication that assertion by purely restrictive clauses is apparent only. The exhaustive discussion of the assertion problem in relative usage seems to belong of right to a special investigation of mode.

Proteus-like, appears, the adequate comprehension of such a clause requires at least some illustration of the equivalence which obtains between it and fellow forms of expression.

Indeed these fellow forms themselves deserve at least a brief enumeration. As closing topic I therefore offer

IV. THE RELATIVE CLAUSE COMPARED WITH TANTAMOUNT EXPRESSIONS.

Confining attention to restrictive usage, but mindful that its comprehension provides a key to the minor difficulties of informational clauses, I note that the tantamount expression nearest of kin to the relative clause is, perhaps, the adjective. To illustrate, "Apples which are ripe" and "Ripe apples" are commonly recognized as essential equivalents in meaning.

For the adjective a participial phrase is often substituted; and in this the participle may or may not be transitive. Thus, "Active men" is readily replaced by "Men exercising," and this again by "Men taking exercise." Each expression, moreover, may be paraphrased by a relative clause, thus, "Men who are active," "Men who exercise" and "Men who take exercise."

The prepositional phrase is also often adjective in function; and in such usage it also is readily expanded into a relative clause. Thus, "The book on the box" becomes without difficulty "The book which is on the box."

Of the adverb proper or immediate adjunct of the verb I can show no exactly equivalent relative clause, because, as indicated on p. 98, no verbal relatives seem to have been developed. That is, I am unable to use a simultaneous factor as verb in a principal clause, and follow it by a verbal dummy, of which latter a special subject, etc., form together a restricter. Thus, meaning that "Brown does his hearty eating at six," I may not say, "Brown eats, he whiches heartily, at six." But I might say, with some stretching of relative powers, "Brown eats which is hearty at six." In this expression "(which) is hearty" is no doubt a restricter of eating; but the eating is conceived for the moment as a substantive. Now I can hardly regard "which is hearty" as overlooking this nearer substantive aspect of eating, in favor of the remoter verbal aspect presented by "eats," While therefore "eats" no doubt obtains restriction from "is hearty," it does not do so in its verbal aspect; and perhaps I can not strictly designate "is hearty" as adverbial in its function.

On the other hand, a secondary or mediate verbal adjunct (adjunct of a verb's adjunct) is not unfrequently replaced by a relative clause. Thus, in "He comes on the occasions on which he is invited," it is obviously my intention to declare of my subject a coming, not universal,

but quite restricted. Both my meaning and the structure of my thought I may vaguely suggest by "He comes invitedly." But the adverb being hardly adequate and altogether unconventional, I resort to the expression "He comes (then) when he is invited," in which it is clear that "he is invited" determines an idea of times or occasions (continued by "when"), which is itself applied (by "then") to "comes."

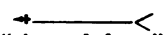
Such restrictive clauses of plainly relative structure imperceptibly shade into clauses of a strictly prepositional order, especially known as adverbial sentences. Thus "He comes if he is invited" may be paraphrased by "He comes in the cases in which he is invited." But in "He will come if he is invited" the "if" expresses rather a relation of condition and conclusion between the inviting and the coming. Though inexpressible, I think, by any single word, this relation is a single idea, and one of the sort as a rule expressed by a preposition. I should therefore regard "he is invited" as merely a substantive clause, which unites with "if" to form a prepositional phrase of adverbial rank. This view is supported by my ability, without loss of any thought-element, and with no material change of structure, to substitute "in-case-of his being invited, in which "in case of" is merely a verbal plexus with an essentially prepositional value.

The equivalence of the relative clause to a conjunction, or rather to a phrase in which a conjunction is used, is much more obscure, being made so in part by Grammar's confusion of several radically different forms of thought construction. It is, to illustrate, one thing to join "apples" and "ripe," by furnishing to them the element necessary to their union in a complete mental trio or thought. Such an element is furnished by "are" in "Apples are ripe." Such a joiner, known in Grammar as a copula, may be specially ranked as an organizer or *uniter*. It is quite another matter to join by "and." In "Six and four are ten" the duty of "and" is plainly to lead my hearer to the formation of an idea-group, to be used as subject of "are ten." Joining of this sort may be specially known as *grouping*. Joining is of yet another sort in "Brown dresses fashionably, *as* does Smith." By this I do not mean to compare the dressing of one man with that of another, but, having made my statement of the one, to repeat it with the other. That is, I make two statements with a simultaneous factor, as appears in the diagram [Brown dresses (fashionably] dresses Smith). If this factor, remaining common, were made successive, my utterance would take the form "Brown dresses fashionably. So does Smith." The effect of making this common factor simultaneous by the use of the merely continuative "as," is to combine what would otherwise be two statements into one. Joining of this sort may be specially known as *linking*.

Of copulative joining nothing needs to be said. Whichever element of an idea-trio or thought be conceived as indispensable to its fellows, that element may be ranked as the copula of the other two; and plainly

such rank may be given to a simultaneous factor as well as to any other factor of a thought.

Of grouping little must be said, as the subject is broad enough and deep enough for a special thesis. I merely note in the first place that, in "Six and four are ten," "and" historically means "in addition to" or "added to." Among the possible methods of thought structure the following is perhaps more plausible than others. Consciously intending "six" as a partial subject, the speaker can however present the same, according to observed linguistic methods, only as if it were his whole subject. The same is true of "four." He can, however, indicate that these subjects are to be taken concomitantly or cumulatively; and, in so doing, he might either indicate that the two are to be taken together, or that one is to be taken with the other. As the latter method is psychologically somewhat easier, it is more natural to suppose it to have been elected, as words like "and" date back to extremely early stages of mental development. Again the speaker, within the limits of this method, may elect to add either the first group-element to the second or the second to the first. Here again, it seems more natural to suppose the latter alternative. To add the first to a not yet mentioned second, requires a greater mental effort, both in exposition and in comprehension, than to add the second to an already mentioned first. I accordingly assume, without attempting proof, that in "Six and four" I mean that "four" is added to "six." Accordingly my thought is as follows: "Six" is partial subject of "are ten;" "four" is also partial subject of "are ten." Between "four" and "six" there further holds the relation algebraically expressible by "plus," linguistically expressible by "in addition to" or by "with" or by "and." But this relation reads backward and not forward. That is, "four" is in addition to "six" (not "six" to "four"), as indicated by the arrow in



"six and four."

"Six" being now a common factor in this last expression and "Six are ten," I may indicate its function in "Six and four" by a relative word. In so doing I elect the word for group-suggestion most tolerant of a relative, namely, "with," obtaining "Six, wherewith (is) four, is ten." That is, the relative clause and the conjunctive phrase are quite equivalent.[1]

Further, in all my effort to show you that "four" is taken with "six" in the formation of my subject, I do not forget that the very aim and

[1] In such phrases Grammar has distinctly missed the really conjunctive word. "And" or "in addition to" or "with" is merely an indispensable element of the idea-trio (thought) expressed by "Six and four." As it advances "Six" and "four" to a new thought-membership it may be said in a sense to join them. But such joining, as indicated, is not distinctive of any thought element, being conceivable of each. The true joiner is "Six;" for it is at the same time a full factor of "Six and four," and a partial factor with "are ten."

object of this grouping is to put both "six" and "four" before you as actually, each, in part, a subject. Accordingly, I put both "six" and "four" in the nominative. Also, having shown you that my partial subjects form indeed a group, I use that form of the verb which is customary when the subject is in the plural number, or consists of more than a single individual. Accordingly my verb is of the so-called plural form.

Linking was illustrated above by "Brown dresses fashionably, *as* does Smith." In this sentence Grammar recognizes that "does Smith" is joined by "as" to "Brown dresses fashionably." In this case, then, the joining regards two thoughts. As previously argued, it is effected by their simultaneous factor, the idea of manner expressed in the first place by "fashionably," and continued by "as." I do not, in this case, need to show that the conjunctional clause is equivalent to a relative clause; for, as already indicated, (pp. 71–2) the so-called conjunction "as" is itself a relative.[1]

The equivalence of expressions noted as tantamount, thus far roughly assumed, deserves more careful verification. In attempting this, I wish to avoid, if possible, the inexactness of Grammar. To illustrate, given "Men who are virtuous are happy" and "Men are happy if they are virtuous," the bewildering statement is made, that the relative clause and the "if-clause" are equivalent.

Such equivalence I am ready to admit, provided only its special nature be clearly recognized. To illustrate this, suppose that "The French king befriended the Pope." If now the befriending be of the tenth century, the king can hardly be of the eighth and the Pope of the twelfth. It may indeed be still more broadly affirmed that, subject, object, or action being, any one of them, conceived as of a given time, the laws by which phenomena seem to be governed, may compel me to conceive the others also in time coincidence. The same is true of space. The same is true in some of the other categories. That is, it may on a given occasion make no essential difference what element of my thought I choose to restrict; the restriction, once applied to either element, may extend to the others. In my initial example I may accordingly say either "Men-who-are-virtuous (leaving out other men) are

[1]As already noted, the simultaneous factor may appear in any function of either principal or relative clause; that is, it varies greatly in structural importance. As I shall further indicate, the simultaneous factor also varies in volume. It would accordingly be natural to suppose that, the bigger and the more important such common factor, the more actual would be the junction effected. Given two calves with even a tail in common, I should no doubt admit their junction. If their common element were the muzzle, I should concede their junction even more readily, recognizing this muzzle as of structurally higher rank than the tail. If the vastly larger and more important trunk or torso were theirs in common, I should regard the proof of junction as overwhelming, and the joining common element as effective in the highest degree.

Oddly enough, however, Grammar reverses such interpretation, recognizing as conjunctions only smaller and inconspicuous common elements. Thus in "There you have the large slice of rare roast beef you are so fond of," it is

happy" or "Men are-if-they-be-virtuous (leaving out other cases) happy." That is, the two expressions are in a sense equivalent.

The special nature of this equivalence may be indicated as follows: Being unready to risk the unrestricted proposition that "Men are happy," I discover two available restrictive methods. I may, by an if-clause, confine the scope of relation between men and happiness (that is, the scope of "are") to the cases in which men are virtuous. Or, by a relative clause, I may confine the scope of "men" itself to such persons as are distinguished by virtue. Either method develops a thought which agrees in substance with external fact, to a degree sufficient to meet the unexacting requirements of speech. In such substantial agreement the methods noted may accordingly be ranked as equivalent. But in structure the two are very different; for in one I have restricted the first term of thought, and in the other the mid-term. This difference between substantial and structural agreement may be reinforced by algebraic illustrations. Thus given "6 $x > y$,' let the coefficient of the first term be transferred to the last, developing "$x > 6y$." These two expressions may be equivalent in the sense that both are true to external fact; but they exhibit widely different inner facts, by which I mean subjective phenomena produced by external fact; that is, they are structurally very different. The equivalence of relative clause and tantamount expression may however be not only substantial but also structural.

Such equivalence I will exhibit by a single illustration, choosing the relative clause in "Apples which are ripe" and its adjective substitute in "Ripe apples" or, in the order common with other languages, "Apples ripe."

In this relative clause the word "which," being not the symbol of any thought-element, but merely the instructional indication how to use an element already furnished to thought, may be omitted. The programme of a procession, even of ideas, is no part of the procession itself. My expressions to be compared reduce then to "Apples are ripe" and "Apples ripe."

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obvious that "the large slice of rare roast beef" belongs in structure at the same time with "There you have" and "you are so fond of;" that is, it is a simultaneous factor of large dimensions and of great importance in each of my thoughts; it surely joins the wholes of which it is a part no less effectively than would a common element of minor bulk or importance; yet Grammar does not recognize it as conjunctive. Again, in "I have the book you want," while the simultaneous factor ("book") is much reduced in magnitude, it remains an element of major importance, being no less than the immediate object of both my clauses; yet it it not conceived by Grammar to be conjunctive. But let the simultaneous factor, retiring from the sentential foreground, appear as merely an adjunct, that is, a common element of minor importance: it may at once be recognized as a conjunction, as in "Brown dresses fashionably *as* does Smith." So also in "He lay as he fell," the common manner-naming factor "as" is usually ranked as conjunctive.

In the adjective expression "Apples ripe" the association of ideas named can be justified only by the existence between them of some recognized relation. Given "Apples" and "ripe" alone, the ideal trio required to make a thought is incomplete. Unless there be between them a relation, they are simply unrelated in the mind; that is, again, they have nothing to do with each other; accordingly the idea expressed by "ripe" cannot have a place as part of my thought. Since, however, this idea, as a matter of fact, does obviously make good its claim to such a place, it must be in relation with the idea expressed by "apples." This relation, I may add, is by no means merely that of an object and a quality; for such relation would hold between horses and "ripe" or "apples" and "blue." It is the relation of an object and its own quality.

How this relation is learned by the hearer is a matter of minor importance. It may be merely inferred. It may be even expressed by the adjective ending.[1] It may be understood from the very association of objective and qualitative words. The important fact is its being there, its actual presence in the minds of speaker and hearer alike.

It appears accordingly that "Apples which are ripe" contains no term or relation which is not expressed by "Apples ripe," either directly or by implication. It also appears that "which" as a mere function sign may be neglected in the comparison of thoughts and their architecture. The subsidiary ideas expressible by verbs, such as beginning (inchoation), continuation or completion, and repetition or singleness of action, do not appear in "are." Even the time-element of the verb, in any case inferrible, is in the present case, no doubt, excluded. "Are" is valid for present, past, or future, being used in this example as a "tenseless" form of the verb. There remains, however, the question whether in "are" there be an assertion, an element of personal belief, which fails to appear in "Apples ripe." The answering of this question will be aided by a momentary extension of our view.

[1] While I do not personally believe this to be the case, the adjective ending being otherwise amply occupied, some indication that it is the case is offered by the use, in German, of the adjective endings on those occasions only in which relation is not expressed by a verb, that is, in the attributive position. Conf. "Gute Männer" and "Die Männer sind gut."

To the distinction between relative clauses, informational and restrictive, a parallel is found in the distinction between restrictive and informational adjectives. The latter type is illustrated in "My sick wife." In a monogamic country, you recognize that the sickness of my wife is quite unnecessary to her differentiation from others possibly my wives. My purpose in mentioning her illness being therefore not restrictive, you, crediting me with some purpose, assume that purpose to be informational. Now, informational relative adjuncts, as previously indicated, are treated like independent information; that is, they are asserted. It may therefore be said that with "sick wife" there is inferred an asserted relation of object to its own quality. That is, "sick wife" means "wife, who is sick," in which an assertion is present.

On the other hand in "Perfect men do not exist," which illustrates the restrictive adjective, the case is very different. Replacing "Perfect" by "who are perfect," I find in the latter no assertion. For, if there be one I am in the untenable position of denying by "do not exist" what I affirm by "are."[1] Now, such an exploit is beyond the daring of even a veteran liar. If I am flatly to contradict myself, you may expect me to put my conflicting statements well apart in time and also in space. You may be quite sure that I will not invite their comparison by putting them in a single sentence. You may safely infer that my "are" is not designed to be taken assertively.[2] So also, in "Apples (which) are ripe," restrictively taken, there is no assertion.

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[1] I am aware that the non-existence or unreality of "men," coupled even with that of "perfection," is not in itself a bar to an existent relation between the two. Thus I may say, analogously, "Centaurs antedate sea-serpents," asserting their time relation, while ready to deny the existence of either "centaurs" or "sea-serpents," and without any feeling of contradiction. But, in "perfect men do not exist," it is not such unreality that I have in mind. I do not commit myself to the denial of either "men" or of "perfection," but merely to the denial of the combination, "perfect men." And this combination I deny, either relying on or at least implying the absence of a combining element, namely, a particular relation. In "Perfect men do not exist" I do accordingly vouch for the unreality of qualitative relation between "men" and "perfection." If now, in "Men who are perfect," the "are" be assertively taken, I am obviously made to contradict myself.

[2] Such use of assertive forms instead of the solely proper unassertives may be charged in English on the general renunciation of the effort to distinguish by indicative and subjunctive between assertive and unassertive thought. The subjunctive being practically lost, both indicative and subjunctive duties fall to

It appears accordingly that there is in "Apples which are ripe" no element which is not at least inferred from "Ripe apples." Any difference between them is then explained by a purely formal word-ellipsis. Grammar, therefore, is right in ranking the relative clause as equivalent to an adjective. The informational relative clause and the informational adjective agree in the nomination of a term betweeen which and a term of the principal clause a relation is recognized, and either actually or inferentially asserted. The restrictive relative clause and the restrictive adjective agree in the nomination of a term between which and a term of the principal clause a relation is recognized, but neither actually nor inferentially asserted.

When a minimal thought, consisting of two ideas and their relation, is increased by the service of one of its terms as simultaneous term of another thought, the latter thought or increment may, as has been shown, appear in several forms of expression. Of these the relative clause has been seen to be peculiarly effective, when the functions of the simultaneous factor in different thoughts are themselves conspicuously different. It is also of the utmost convenience in the lack of single words or phrases to express a required meaning. For the relative allows the detailed formulation of a thought complete, being in this particular no wise inferior to a sentence. Now, a sentence is the embodiment of the powers of speech. Whatever power of expression, therefore, resides in a language may be utilized in the relative clause. To illustrate, wanting a servant, and in particular one distinguished from others by the thorough currying of horses, and having no adjective to express this conception, I say that "I want a servant who curries horses thoroughly." In this particular case I might indeed do measurably well by using the virtually adjective phrase "distinguished by thorough currying

the indicative mood. The modal value of the latter is accordingly equivocal; the forms entitled by English Grammar indicative mood should rather be designated as indicative–subjunctive. In other languages such inconsistency may be explained by the supposition that this modal distinction has sometimes proved a bit too subtle for the average mind, the type of mind by which, of necessity, linguistic usage has mainly been determined. Sometimes the irregularity may be placed to the account of a common inability to let well enough alone, which reveals itself not only in formally double assertion (e. g., "I believe that he is honest," which says no more than "I believe him to be honest"), but also in formally double negation (e. g., He isn't honest I don't think).

of horses." But, in yet more amplified restrictive conceptions, I feel the positive need of a full sentential structure. To illustrate, "The man who, expecting to find him absent, called on my greatly esteemed guest this afternoon, with his son, in order to square his social account without the loss of time involved in a personal meeting, has lost my good opinion." In this example the primary elements of my adjunctive thought are expressed by "man" (of which the second function is indicated by "who"), "called on" and "guest." Whatever be then the multitude of further, secondary elements, in dealing with them I have the great advantage of three visible terms, among which I can apportion their government; while, even if I could replace these three by an adjective, I should be left with but a single term available for governing purposes, namely the adjective itself. Generalizing, I may then say that the relative clause has this advantage over tantamount expressions, that in it the labor of marshalling reinforcements is divided among three terms.

Of these three terms moreover the verb, I think, is the most competent; that is, it can handle more adjuncts and more effectively than either its subject or its object. It also has uncommon instructional powers, showing by its number and person what is its subject, and indicating by its modal inflection its own function as term or adjunct.[1] Incidentally, too, as a single word, it can express more ideas than any other sentence-element: it adds to its fundamental meaning, by mere inflection, useful accessories such as time (in the sense of either Zeit or Mal), and such as initiation, continuance, or completion; also it chooses by its voice between the proverse and reverse aspects of the same relation.[2]

It appears accordingly that, when a sentential increment is small in bulk and simple in structure, almost any one of the tantamount adjunctive expressions is adequate; but, when the bulk and complexity of the increment imperil its structural clearness, relief is sought in a form of adjunctive expression, in which all the powers of speech may be exploited, that is, in the

[1] Compare "amat," "(ut) amet," and "(qui) amet."

[2] Thus in "Homo occidit ursum" "occidit" shows relation to be that of slayer to victim, while "occiditur" would show relation to be that of victim to slayer.

relative clause or, in other words, the adjunctive expression which has the sentential structure.

In comparing the tantamount forms of sentential increment, I accordingly feel justified in ranking the relative clause as the highest species; it presents a thought with the fullest analytic completeness and commonly provides a special symbol for each of its elements; it alone distinctly recognizes the double function inherent in simultaneous factorship. It is also, no doubt, the most effective, especially when the increment is bulky or complex. It is, however, more than others, dangerous in the use of the unskilled, being often used on wrong occasions, and also often wrongly constructed, even on right occasions. It is of all, moreover, the least necessary, as appears by its total absence from several languages, its comparative infrequency in many, and its not uncommon neglect in all.

APPENDIX A—PERSONALS.

HOW THEY DIFFER FROM OTHER WORDS.

This has been suggested in Chapter I., and will be emphasized again. Words like "I" are imprimis initiative and not, as a rule, vicarious. As initiatives they are further distinguishable from the indefinite members of the initiative class, being obviously definite.[1] Again, as definites, they are distinctly of the egocentric type. To the most superficial observation it is plain that the values of "I," "thou," etc., change with the change of their user. But this peculiarity is shared by "this" and "that," by "come" and "go;" to separate the personals from these, a further distinctive is required.

Such a distinctive has been found for the personals in their restriction of the egocentric view to the phenomenon of speech, it being held that such an idea as that expressed by "thou" could not be developed, except in the field of thought-communication. It therefore seems sufficient to designate the personals as words which egocentrically distinguish the participants in thought-communication.[2]

HOW THEY DIFFER ONE FROM ANOTHER.

The fact that the personals change their value with the change in the user forces our examination to elect one user as a guide and to abide by his point of view. For convenience I adopt the view-point of myself, rejecting the Pharisaic formula "I am not as other men." It is true that our ego-centric ideas are very

[1] For the occasional indefinite use of "they," "you," etc., see appendix C.

[2] In carrying out this view some difficulty offers in the case of "I," which appears as common term of the spatial series "I," "this," "that," and the colloquial series "I," "thou," "he." It is plain that "this" and "thou" are very different, as also "that" and "he". The question rises whether the "I" of one series be also different from the "I" of the other. Frankly admitting that the question is too deep for my own psychology, I merely suggest that they seem to me the same, a change of category not appearing to require change in idea. The same point may be a part of two lines, without assuming a double character. The same self may be differentiated from persons (or things) in other places and

different, your "right" and "left" of space or your "before" and "after" of time being, it may be, opposite to mine. Yet, so to speak, by a turn of the wheel, our categories coincide; and I assume that also in the field of thought-exchange the case will be the same; that is, our categories tally, though we apply them differently.

I further confine myself to oral speech, regarding written language as a mere transliteration, a trifle different from the oral in its use of personals, because the colloquial participants are not in mutual presence. But I assume that such difference is the easy corollary of mutual absence and will not essentially modify conclusions drawn from the study of oral speech. For analogous reasons I mainly neglect the examination of soliloquy, of speech "in concert," of the figurative address to that which can not answer or understand, and of the use of language as a mere notation.

Used as a means of oral thought-communication, language requires two participants at least. Choosing in illustration the leading rôle for myself, to avoid entanglement otherwise imminent, I note that, while speaking, I am active; you are comparatively passive. In thought formation I am an originator; you are at best an imitator only; you merely "think my thoughts after me." I give; you receive. The source of a stream of energy is in me; in you it discharges. Without you, indeed, the message is not received; but without me there is no message.

Indeed my every statement contains me by implication, even when I am not mentioned. For instance, suppose I say that "The moon exceeds the sun." It is true that my sentence contains no mention of myself; yet you appreciate that this sentence does not stand of necessity for a fact, but for an opinion, and that this opinion is mine. Fully rendered, my statement would take the form: "I believe in the reality[1] of the moon's

again from persons otherwise implicated in speech, without being modified in my conception. It is possible, no doubt, that the "I," as antagonized to "this" and "that," is conceived especially as having location and that the "I," as antagonized to "thou" and "he," is conceived as colloquially active. But it seems to me that the "I" is rather absolute and invariable, an origin of coördinates, unaffected by the point of view because itself the point of view. I should accordingly tabulate: "I" (absolute), "this" and "that" (spatially related to "I"); "I" (absolute), "thou" and "he" (colloquially related to "I").

[1] My belief in unreality, etc., would be expressed by "The moon not exceeds the sun," or an equivalent.

superiority to the sun." In the business then of speech I am, when speaking, ever conspicuous. The fact that you are also a sharer in this business may or may not be specially indicated; and, even when it is so indicated, it is only as a minor associate that I recognize you. I rank myself as the senior partner.

A moment later our respective rank may change. In answering me you are in turn, in your own estimation, the speaker, the first person, the protagonist, the leading actor on the stage of thought-exchange. That is, your estimate of yourself will tally with my previous estimate of myself.

But I shall not fully accept your estimate. Though I cease to speak and become a listener, I do not forfeit, in my own estimation, my linguistic prestige. Putting myself in your place, I assent indeed to your use of the "I," to designate yourself. But this assent is based upon a mere hypothesis. From my point of viewing the actual, I alone am "I." I do not speak of myself as "thou" or recognize that another is really "I." The fact that a converse view is taken by every other person, the fact that is, that no one calls me "I" except myself, and that every one appropriates the "I" in self-designation, is merely the fact that the egocentric view-point is, in matters colloquial, not pecular to myself.[1]

The other required participant in thought-communication is a hearer. Of the several sorts of hearers, I have in mind for the moment the intended hearer only. There may indeed be more than one such hearer, but this case of mere plurality may be neglected.

My intended hearer is such, of course, from the special view-point of myself. The person addressed by me, it is true, may coincide with the person addressed by you or by another; but this is the merest accident. He is to me a person addressed, so far alone as I address him. The aims of others than myself are to me irrelevant. "Intended hearer of what I have to say" may be accepted as expressing what I mean by "thou."

[1] This essential immutability of "I," even when the rôle of speaker is exchanged for that of hearer, further indicates the absoluteness of self-conception. The speaker, it is true, uses the "I" only when speaking of himself, that is, of a speaker; but his reason for using it seems to be, not that he is the speaker, but that he is self; whether this self be speaker or hearer seems to be at least of very secondary importance. "I," then, is the name for self in the absolute, whether speaking or hearing—being, thinking or acting—in "splendid isolation" from all else that is.

While I may or may not expect from you an answer, the possibility of an answer seems to be always contemplated. Even while I speak, you are the condition of thought-communication; a moment later you may become its cause. While I then am the actual senior partner of the moment, you are the potential senior partner of the moment to come. In your present participation, you deserve at least as high a rank as that of junior partner.

Besides the speaker and the intended hearer, there may be another hearer (or several), present, perceived, accepted, but not intended. Such a one it is simplest to conceive for the present as also not expected to assume the lead. You and I then, in the alternating rôle of speaker, have no objection to his hearing what we say; but neither of us is talking for his sake. If you or I were absent, what either now is saying for the other's sake would not be said at all.

The colloquial rank of such a hearer is plainly quite inferior to our own. Far from being indispensable, he is distinctly supernumerary. Our thought-exchange may be not more complete, because he is present, nor less so, be he absent. His participation in the act of speech concerns not us at all, but himself alone. He does not even merit the name of a hearer. He is rather an overhearer, or a silent partner.

If now I wish to mention such a hearer, I may speak either to or of him. The former alternative merely makes him a junior partner, suggesting nothing new to our examination. The latter allows me to designate him absolutely by his name (a method foreign to the present inquiry, or egocentrically. But even egocentric designation, to deserve our notice, must not be merely in the broader meaning egocentric. "That man" and "this person" are egocentric in such broader meaning; but they lie without the present field. To lie within this field, the designation must be an egocentric of the specially colloquial type; it must name the overhearer by a word suggesting a colloquial participant, but not a speaker or an intended hearer. Such a word is "he" (or "she").

I do not mean that this is the only or even the common meaning of "he." Indeed this meaning is somewhat rare. From the usage of the polite it has disappeared, for the very obvious

reason that it slights the person mentioned. But as one of the names for colloquial participants or strictly "personal pronouns," "he" must in this meaning be emphasized and, I think, alone recognized.

So far as "it" is concerned, I do not remember any usage in which it is personal in the present restricted sense, except as word of either gender, applied for instance to a babe or child of unknown sex.

By extension "he" is made to name any person present, even one by deafness excluded from the rank of hearer. Such usage begins an obvious transition to the demonstrative category, "he" in this case approaching the meaning of "that person." However, distinction from the senior and junior colloquial partners still is dominant, rather than spatial relation to you or me.

With the colloquial trio, composed of speaker, hearer and overhearer, the list of participants in thought-communication may be regarded as complete. It is true that in the act of speech there may be other quasi participants. These may be distinguished, in a sense, as secret partners, including the hearer whose unnoted presence is accidental, as well as the intentional eaves-dropper. As such, however, figure only in their own consciousness or, if perceived, take rank at once as participants of the already mentioned orders, they may safely be neglected.

THEIR SO-CALLED PLURALS.

Grammar will have it that "we" is the plural of "I." In striving to reduce this proposition to absurdity, I make at once the somewhat difficult concession, that "we" may have developed from "I," somewhat as "cows" or "kine" developed from "cow;" that is, the "we" may have the form appropriate to a plural word and be moreover derived from "I." I contend however that the meaning of "we" is not a plural meaning, and that, even if it were, it could not be plural to the meaning of "I."

Overlooking the artificial use of "we" by royalty, the editor (collaborator) and him who deems it more modest to speak of himself as many than as one, I first observe that plurality is something more than multiplicity. Thus a cow and one or more other cows assuredly constitute a plural, while a group made up of a cow, a horse, and a goat, is only a multiple. By modification it is doubtless easy to make it a plural. If you

choose to overlook the mutual differences between group-members; if you are content to conceive those members as merely so many animals; the group becomes at once undifferentiated, homogeneous, and accordingly a plural. But this plural is by no means that multiple. Original differentiated constituents have been discarded; others undifferentiated have been substituted. The fact that the substitutes form a plural does not even suggest that their originals do the same.

The case of "we" is closely parallel. This appears most plainly when "we," as recognized by Grammar, has the value of "he, thou and I." The persons designated form indeed a multiple group, but one by no means plural. By modification they may no doubt become a plural. Thus, if you overlook the mutual distinctions of "I," "thou" and "he" (as speaker, hearer, and overhearer), and merely conceive the three as so many colloquial participants, ideas named, being now undifferentiated and accordingly homogeneous, form no doubt a plural group. But, in this case also, original group-members have beeen discarded; others very different have been substituted. The fact that the substitutes form a plural offers not even a hint that their originals do the same.[1]

Again, were "we" a plural, it could not be the plural of "I." To illustrate, speaking of the soldiers' voting in the early sixties, I might say that "The regiment voted mainly for Lincoln." It is plain that "regiment" stands in this sentence rather for a number of individuals than for their total conceived as a unit; that is, "The regiment" names a group. Suppose it now to be claimed that "regiment" is the plural of a particular captain. It would be difficult to show why this particular captain should be preferred to any other captain, or to some other officer, or even to a private. Yet, as the regiment does contain a number of captains, such a claim might be tolerated; for it does not, at least, insult the quantitative instinct. But were it

[1] In other words "we" can become a plural only by losing the meaning of "he, thou and I," and assuming the meaning of "three undifferentiated speech-participants." That "we" might do exactly this, I regard as neither impossible nor absurd. But, as a matter of fact, I believe that even a "thou" and a "he," as constituent factors of a "we," maintain their mutual differentiation—to a degree at least much greater than two "hes" or two "thous" in a "we" consisting, say, of five persons: e. g., myself, two Smiths addressed and two Robinsons not addressed.

claimed that the regiment is plural of its colonel, a halt would surely be called, on the ground that a plural of colonel must contain more colonels than one.

So, too, were it claimed that "we" is a plural of "thou" or of "he," it might indeed be hard to see why it is more a plural of one than the other. Yet the claim might sometimes have a quasi plausibility; for sometimes a "we" contains more than one "he" or more than one "thou." But when summoned to accept the doctrine that "we" is the plural of "I," the powers of faith are overtaxed. For the idea named by "I," is from the user's view-point, absolutely unique. A plural of self is accordingly a mystery even more difficult than that of the Trinity. There simply cannot be a plural (that is, many) of that of which there is but one. The triumvirate is not the plural of Antony; nor the ox, of his lights, pluck, or liver; nor the regiment, of its colonel; nor United States, of Wisconsin; also "we" is not the plural of "I."[1]

To redefine the "we" is by no means easy for one embarrassed still by mental habits formed in a long acceptance of false teaching. The scope of the word, moreover, in literal and figurative use, is so wide and varied, that the danger of an oversight is extreme. I therefore make a tentative effort only, in venturing to define the "we" as the name of any group in which the "I" is a member.

In the case of "you," I neglect the vagaries of colloquial etiquette, which make even a single "thou" appear in various languages either as singular or as plural—of the third as well as the second person. Considered in its normal value and in relation to a normal "thou," the "you" may be defined as naming any group including "thou" but not including "I."

The use of "they" is even further restricted, the word (in its now considered value) being definable as the name of any group including the colloquial "he" ("she" or "it"), but not including "I" or "thou."

[1] Since reaching this view I find it adopted by Kern and one or more others. In further illustration, compare the procedure of Grammar with that of the ex-military mendicant, who invites charity by a placard inscribed as follows: Battles 4, wounds 5, children 6; *total* 15."

THEIR SENTENTIAL RANK.

The words thus far examined, though somewhat peculiar in meaning, being specially characterized by their purely egocentric validity and by their restriction to the act of speech, are merely nouns.

In seeking their mutual differences, I note that the use of "thou" is somewhat analogous to that of "grandfather." Each may name a person in his relation to myself, their difference being merely that relation is in one case colloquial and momentary, in the other ancestral and permanent. Each may be applied to different persons; each may be used by many persons; indeed, in either aspect "thou" is much the broader word. The same may be said of "he." I see no reason therefore why "he" and "thou" as well as "you" and "they" should not be ranked as common nouns.

The case of "I" is very different. To illustrate, suppose my name be Cicero, and that no other person bears, or ever bore, this name. Examining "I" and "Cicero" from the special view-point of self, I find that each, in my personal usage, means myself alone. They differ merely in this, that "I" is my egocentric, naming me from the special view-point of self, while "Cicero" is my absolute, naming me from no special view-point of my own. "I" names me as part of the universe in its special conception by myself; "Cicero" as part of the universe in its conception by anyone. The difference is essentially that which obtains between "here" and "Lat. 43° N., Long. 90° W." From the view-point of my individual usage, I think both "I" and "Cicero" should rank as proper nouns.

Looking now from the view-point of others, I can strengthen my comparison by including an intermediate term, for instance, "Smith," which, although a proper noun, suggests a formidable portion of the race. Accordingly, "Cicero" may be used by one man only, to name himself; "Smith," by many men; "I" by all men. "I" is, in a way, an intensified "Smith." The three designations are respectively unique, generic and universal. In passing from "Cicero" (and "Smith") to "I" we have indeed forsaken the field of absolute designation and entered the egocentric; and so I do also in replacing "614

State Street" by "home." But, just as in "I am going home" I use the word "home" with an individual value and by no means generally (as in "The homes of the working classes"); and just as in "Grandfather is ill" I name to my friends a particular person even more distinctly than by "Mr. Brown;" so also in using the "I," it appears that I name a single particular individual; and other persons, in using the same word, do the same. The fact that this individual varies in the usage of different speakers cuts no greater figure than similar variation in other ego-centrics. "Mother" and "Father," as used in the family circle, I have always felt to be proper nouns and have always written them with a capital. I am merely consistent, in expressing the opinion that "I" should also rank as merely a lexically somewhat peculiar proper noun.

The adjective use of personals has been to Grammar, as might be expected, the source of some embarrassment. While "whose" in many languages is recognized as merely a genitive of "who" relative or interrogative; while "one's" is consistently grouped in declension with the nominative "one;" "my," "thy," "his," etc., are wrested from their cognates "I," "thou" and "he," and marshalled in a separate division, commonly known as possessive adjectives.

The motive for their isolation may be sought in the fact that, in many languages, they are adjectively inflected. But such inflection is an accident, without reliable value. In "Er ist ein zu liebender Mann" "zu liebender" is merely an adjectively inflected oblique infinitive. In "Elle est toute bonne," "toute" is merely an adverb falsely invested with adjective inflection. In "eine nach-haüsische Fahrt," "nach-haüsische" would merely be an adjectively inflected prepositional phrase. This phrase and the oblique infinitive both, no doubt, deserve to rank as of adjective function; that is, their ideas enter the structure of a thought precisely as do the adjectives themselves. But as Grammar commonly means by an adjective something more than this, it is necessary, to avoid confusion, to examine a little further.

Given "wolf," the noun, and "wolfish," the adjective, it is plain that the latter has lost the objectivity of the former, shrinking to the expression of quality alone. "Wolf," again, suggests

with more or less distinctness not only an individual being, but also quite an outfit of qualities. In "wolfish" the tendency of these is to become less numerous; in a "wolfish appetite" one only may be conceived; indeed even this may lose everything except intensity. What is more important still, no idea foreign to "wolf" is grafted on the idea expressed by "wolfish."

In the word "my," on the other hand, there is no abatement of self; and no quality connoted under "I" is lost; per contra the important idea of possession is added. "My" differs from "I" or "me," much as "Indian-owned" (in the sense of owned by Indians) differs from "Indians," for instance in "Indian-owned lands." As "my," with the value of "by me owned," is ranked as the adjective of "me," consistency requires that "Indian-owned" be ranked as the adjective of "Indian." So also, by strict analogy, "shark-eaten" and "man-eating" rank as adjectives, the one of "shark" and the other of "man." Obviously the initial move of Grammar leads to much that is beyond the grammatical purpose. It is better, perhaps, to admit that "my" is not the adjective of "I" in the usual sense employed by Grammar.

It is also but a part of the truth that "my" is possessive. "My" has doubtless the meaning "of me;" and "of" may certainly name the relation of owner to property; "of," that is, may have a possessive value, as in the "book of me" or "my book." But "of" may have and often does have other values, many and very different. Conceiving myself a boy again, I lament "my punishment by a teacher." "My," as usual, stands also here for "of me;" but this time the protean preposition expresses the relation of action (punishment) to its actee (sufferer, object), myself; or, in other words, "my" is the objective genitive. Or, letting the teacher speak, "My punishment of that boy was proper." Again "My" stands for "of me;" but this time also "of" expresses not at all the possessive relation, nor that indeed of action to actee, but the relation of actor to his act, "My" being now a subjective genitive.

Grammar seems, moreover, to misconceive the sentential rank of "mine." To illustrate, in "This book is mine," the value of "mine" being taken as "my object," "mine" itself is rated

a noun.[1] It is however worthy of notice that "mine" is even today much used with the value of "my;" that many languages have but a single form for both;[2] that the difference in their usage tallies with a difference always made in German between the adjective as adjunct and the adjective as term.[3]

The grammatical opinion is merely a special application of that advanced by some logicians, who deny the use of the adjective as term. Its holders will have it that "The rose is red" is at least an impropriety; that the careful thinker must conceive that "the rose is a red object." However convenient such structure of thought may be in a purely logical notation, it seems to me self-evident that it is not followed in thought, as prepared for ordinary linguistic expression. Much argument to the contrary, I may think no doubt by the method indicated in the expression "Redness (by no means a red object) characterizes the rose;" I may also reverse my mental current in "The rose is characterized by redness (by no means a red object);" and this latter sentence expresses exactly what I think I mean by "The rose is red." That is, the rose and its redness only are put before you in the relation of an object to its own quality.

I do not accordingly find that "object" is to be supplied either in "The rose is red," or in "The rose is mine." I therefore rank the "mine" as a predicate adjective, (or, more strictly, as the predicatively employed genitive of I) somewhat distinguished from the attributive, as in German, by a different termination.

In "Lieutenant Brown of ours" a closer approach is made to strictly substantive usage. So far as "ours" shall mean "our regiment," it is, no doubt, a noun. If it be admitted that an ellipsis has occurred, and that "regiment" is supplied, then "ours" remains an adjective. This purely lexical question may be dismissed with the remark that comment similar to the above may be made on "thy"—"thine," "his"—(his'n), etc.

It has apparently escaped the notice of Grammar that the use of pronouns adverbially is at least a linguistic possibility. So far indeed as "my" is the adjective of "I," so far "usward"[4] is the adverb of

[1] E. g., in French grammars.
[2] Conf. meus, tuus, leur, loro, etc.
[3] Conf. "Die schöne Frau" and "Die Frau ist schön."
[4] This word, so far as noted, is preceded in English by a superfluous "to," as in "God's mercies to usward." But in German dialect "unserwärts" appears unaided, as an adverb.

"us." The addition of new matter to the primary idea expressed by "us" is surely no more important than the addition in the case of "my." Plainly, however, both "my" and "usward" go far beyond the ideal reach of their primitives. The immediate adjective of "I" would be expressed in German by a theoretical "ichisch." Thus, what you or I would call a "Napoleonisches Gesicht" the emperor himself might have called an "ichisches Gesicht." And obviously the same imaginary word might also be adverbially used. Thus, "Das hat er recht Napoleonisch gethan" would take in imperial parlance the form, "Das hat er recht ichisch gethan."

The gist of "possessive" peculiarity may then be put as follows: So far as structure of thought is concerned, "My coat" is the same as "The coat of me;" the latter is structurally on a par with "The coat on me;" and this, again, exactly tallies in structure with "The coat on the chair." The "possessive," then, is but a prepositional phrase, expressed by multiple symbolization in the form of a single word. This word, moreover, often assumes, but by no means always, the adjective inflection. This inflection, accordingly accidental, may be the more safely overlooked that it is neither ideal nor functional but purely associational; see p. 62.

THE SENSE IN WHICH THEY ARE PERSONAL.

Words of the present class are sometimes defined as pronouns which stand for persons. Overlooking the fact that some of them almost exclusively stand for things, I note that "who," in either interrogative or relative usage, is claimed by Grammar itself to stand for persons, though not admitted to personal rank; and many indefinites, for instance "some" (as in "Some say, etc.,"), as also the reflexive "myself" and others, have equal claim to personal rank. Plainly the definition includes too much. Again, in figurative usage, all the personals extend their scope beyond the range of persons. The definition therefore plainly includes too little.

Personality indeed, in the given sense, is quite beside the question. When of my horse, my dog or my pipe I use a "thou," it is in spite of their not being in such sense personal, and because I am talking to them. And when, in talking to a man, I address him as "thou," it is solely because I am talk-

ing to him, and not at all because he is a person. That is, whatever I have in mind, its presentation by a "personal" depends by no means on its rank in my classification of things animate or inanimate, but on my classification of participants in the act of speech. If then I wish the word personality to suggest the true distinctive of the personal words, I must define it as meaning egocentricism of the specially colloquial type;[1] and this I take to be the meaning of "person" as used by Grammar in the more special sense.

HOW FAR THEY ARE PRONOMINAL.

To the strictly personal words, as noted in the second paragraph of Chapter II., Section 10, a vicarious value is sometimes superadded. Such occasional double value has presumably helped grammarians to regard the personals as pronouns, to infer, that is, that personality entails pronominality.

Without exhaustive examination, I will merely test this inference by bringing, so to speak, a suit against a single one of the personals, choosing as defendant the so-called pronoun "I," the usual leader of the pronominal list. Suppose then that, meeting you for the first time, say in a stage-coach, I remark that "I am glad to have a companion." It surely will not be claimed that, in this sentence, "I" is in any sense a substitute for any other word or phrase. In the first place "I" is not a *re*placer; that is, it does not, as sign of an idea already mentioned (or yet to be mentioned), take the place of any word that *is actually* used and might be used again. "I," in the second place, is not even a *dis*placer; that is, it does not, as sign of an idea in its only mention, take the place of any word that *might be* used. The word "I" stands for myself, not only immediately, but also with such perfection, that no other word or combination can advantageously take its place. Even my legal name is comparatively uncertain. If you do not already know me, and if another be present, you readily take that name

[1] It goes without saying that such "personality" may appear in other symbols by no means recognized by Grammar as personal pronouns. Thus, in "Our Father, who art in Heaven," no doubt the "who" (while serving as an order to continue "Father," and as a sign that "Father" is, in second function, nominative), contemplates the "second personality" of "Father" in its second function.

as standing for that other. Such laborious circumlocutions, too, as "your humble servant," "your prospective fellow-traveler," etc., are felt to be at best extremely clumsy substitutes. If any of these words or phrases shall be reckoned as taking another's place, it can hardly be the "I," but rather my name or any circumlocution. To rank the "I" as a verbal deputy is, then, to misconceive the procedure of speech completely.

The fact that a genuine personal is occasionally used with added vicarious value, does not justify the inference that every personal is a pronoun. Though Democrats are sometimes Baptists, I may not therefore rank the former as a sub-class of the latter. So also, though personals be sometimes further used vicariously, that is, as pronouns, it is only their vicarious usage that admits them to pronominal rank. As merely personal, as egocentrics, that is, of the colloquial type, they are not also vicarious; that is, by the definition of Grammar itself, they are not pronouns. Per contra, when they are not only personal but also vicarious, their personality ranks, in a strict pronominal classification, as merely a lexical accident.

APPENDIX B—DEMONSTRATIVES.

It was indicated on p. 13 that these express the egocentric ideas which are not developed under influence of the act of speech. Few of them are recognized at all by Grammar, and even these so indistinctly as to remain effective stumbling blocks. Their determination and mutual differentiation form a strictly lexical problem, of which I can offer only the merest outline.

Examining first

THEIR CATEGORIES,

I note that the condition of every egocentric idea—every idea, that is, which takes its departure from self—is obviously the establishment of self, as point of departure. Egocentric thought of any kind assumes a prior distinction between the self and all else—the I and the not-I. To this distinction the constant presence of self in consciousness may be noted as an excitant. For linguistic purposes the "I am always with you" may be reformulated as "I am always with myself." Other ideas are occasional; the idea of self alone is ever present. That the one abiding idea of self should serve as landmark for other ideas is a foregone conclusion.

Such a landmark is available in many fields of thought. In the category of space it is plain that all that is not "I" may be subdivided according to its *distance* from self. Thus, in English, what is near me I designate by "this," and what is more remote by "that." Spanish recognizes three degrees of distance marked by "esto," "eso" and "aquello." Indeed a larger number of such degrees is possible and entirely practicable.[1]

[1] Under colloquial influence the regions of remoteness or of nearness somewhat tend to use the hearer as a landmark, "that" inclining to confine itself to what is near to you, and the "yonder" affecting what is far from us both. But even in conversation such a tendency is merely a putting of myself in your place, that is, an application of my own egocentric classification to your point of view (in soliloquy my personal point of view is unchanged); the definition of "that" as what is near to you, must accordingly be rejected as giving neither its primary nor even its commoner meaning.

Next to the question how near an object is, may rise the question which way it lies or, in other words, what may be called its *bearing.*[1] To illustrate, while the phrase "this hat" denotes an object near to me, it gives no indication whether it be *on* my head or *under* my feet, *before* or *behind* me, at my right *(rechts)* or my left *(links).* But each of the italicized words refers the hat to one of three dimensions of egocentric space and further, using self as a center, shows the section of that dimension to which the object belongs. There is indeed some tendency to confine these words to objects somewhat near; but in "above" and "below" this tendency fails to appear and, even in the others, bearing itself is distinctly and, I think, primarily indicated.

Passing now to the egocentric indication of motion, I can suggest it best by reference to a line conceived as the path of the moving object. On such a line it is plain that opposite motions may occur. That is, in addition to given terminals, motion has what may be specially known as *direction.* For instance, of motion on the line A B, there are two kinds, one from A to B and the other from B to A. It is obvious also that one at least of these terminals must be somewhat definitely conceived. A motion from "here" to "there" I readily grasp in its antagonism to a motion from "there" to "here." So also I easily differentiate a motion from "here" to "anywhere" and a motion from "anywhere" to "here." But a motion from "anywhere" to "anywhere" is not in itself sufficiently fixed to permit me to conceive an opposite.[2] Neglecting motion thus unavailably indefinite, and examining first the case in which both terminals are somewhat definitely fixed, I note that "forward" means along a line from myself to a point in front of me.[3] "Backward" means along the same line, but in the opposite direction. Also "backward" means along a line from my-

[1] This awkward technicality I use to avoid confusion with direction, which is examined later.

[2] In egocentric usage the terminals of the motion line (e. g., from "here" to "there") are either self or determined from self as a landmark. Contrast therewith the absolute "northerly," "southerly," northeasterly," etc.

[3] It is true that in "Forward Co. A!" I reckon direction from the view-point of my hearers. But this point of view, again, I merely adopt for the moment. In such a phrase as "on *your* right" I advertise such adoption. In "Forward Co. A!" I let this adoption be understood. Conf. "Sind Sie da?" and "Ich bin da." (=I'm what *you* call da.).

self to a point behind me, and "forward" the opposite. Turning to the case in which one terminal only of the motion line is fixed, I note that "hither" means along a line from anywhere to at, or near, myself, while "hence" denotes the opposite. "Thither" denotes a motion from anywhere (but with a little preference for self) to a point "there," that is, a point determined by self as a landmark; "thence" denotes the opposite.[1]

In the above illustration direction is an abstraction from motion, conceived as an attribute of motion, while motion itself is expressed by another word. But sometimes the motion per se and its direction unite under a single designation which may be roughly known as *course*. Thus "to come" means to move along a line, one end of which is at or near myself. By "to go" is commonly meant a motion along the same line, but in the opposite direction.

By the usual transition egocentric distinctions pass from the field of space to that of *time*. What is "now" belongs to the actual self, as distinguished from the self remembered or anticipated. Time remote from the "now," but not distinguished in direction, may be indicated by an equivocal word such as the Latin "olim." Or the two divisions of time not "now" may be indicated, as in English, by "once" and "some time," which indicate respectively the past and the future.

Thought-nearness is also egocentrically distinguished. "*This* kind" (e. g. "this kind of men") and "*that* kind" may both include what lies within my mental horizon of the moment, what lies without being expressible by "*other* kinds;" and "*this* kind" again may stand for what is focal in consciousness, while "*that* kind" names an idea comparatively marginal.[2]

[1] By an easy transition many spatial words become entirely indefinite. The ideas expressed by "hence" (from this place) and "thence" (from that place) are grouped with their possible kin under such words as "off," "away," "hin." Again, when once incapable of expressing alone an even approximately definite direction, they are ready to enter vicarious service. Thus, in "Brown used to live here. But he has moved *elsewhere*," the last word means "a place different from here," conceived as term of a motion from here. That is, the "elsewhere" is partly reinstative and partly initiative.

[2] Somewhat similar is the use of "he" to denote the person par excellence of common acquaintance. To illustrate, "'He cometh not,' she said." The idea expressed by "He" is obviously that of an individual likely to assume the focal position in the minds of speaker and hearer. This focality may be regarded as normal with the speaker and recognized as such by the hearer. When it becomes established to a sufficient degree, such "he" acquires a footing inferior only to that of the "I," with which I think it may be classed rather than elsewhere, ranking essentially as a proper noun.

Manner, too, is the subject of egocentric distinction. To illustrate, noting your method of tying a knot, I remark that "I cannot do it *so* (in the manner shown by you); I do it *thus* (in the manner now shown by me or yet to be shown)".

Family relation is commonly viewed in the egocentric aspect, "Father," as used by me, standing for one who may be to you a nephew, cousin, etc., or an entire stranger.

Professional status is also at times a matter of purely egocentric determination, my lawyer being, it may be, your doctor or your spiritual adviser.

To call upon the science of linguistics to present completely the egocentric categories, plainly would be unfair and useless, particularly since at present even the simpler categories are far from being adequately understood. As a merely interesting suggestion of the extent to which the egocentric tendency enters idea-formation, I offer an illustration from what may be called the *social* category. In a society made up of a ruling class (including, say, nobility, clergy, and military), a middle or bourgeois class, and a laboring class, the prestige of the bourgeois depends entirely upon the class view-point from which he is regarded. Suppose now that you are a noble and I a laborer. As used by me the epithet "bourgeois" is an expression of esteem, while in the usage of yourself it is an expression of contempt. In fact, in certain styles in French, the designation "bourgeois" (or middle class) has discarded the absolute value and adopted that of "above me" or "beneath me," according to the social status of the speaker.

THEIR SENTENTIAL RANK.

Assuming my reader to be no less weary than myself of verifying in actual usage the obvious ability to use any idea as any element of thought, I confine myself to the merest suggestions. Preferring an epistolary illustration, because it allows a variation in time which does not occur in oral thought-exchange, and using poetic phraseology, to avoid an embarrassing auxiliary, I imagine that you write me in the evening a note as follows: "Came you here today?" My answer, dated the following day, is this: "I went there yesterday." In this ex-

change of thought, what you express is a desire to learn my opinion about an act; what I express is my opinion of that act. But as neither your desire nor my opinion materially affects the description of the act, we may neglect them both and merely regard the letters as act-descriptions. Now it is somewhat striking that in these descriptions, though the act is the same, the words elected to describe it are, without exception, different. That is, we both of us abide, in every element of thought, by the egocentric point of view. And in our sentences we hold to our view-point in every sentence-element or "part of speech" employed. The "I" and "you," indeed, are specially linguacausate; but in "Kam jener hier diesen Tag?" and "Dieser ging dort jenen Tag," all words but "Tag" are aliocausate, that is, demonstrative. Examining their rank as parts of speech, I find in each sentence an adjective (diesen, jenen), an adverb (hier, dort), a verb (kam, ging) and a pronoun (jener, dieser), or, as I have previously urged, what should in no way be distinguished, in substantive usage, from a noun.

Passing to more difficult parts of speech, I note that what is "*a* house" from your point of view may very well be "*the* house" from mine, the article, or weakened demonstrative, assuming, as would be expected, the egocentric aspect. Verbal nouns and verbal adjectives follow the lead of the verb itself. Prepositions are even specially prone to presuppose an egocentric point of view, as abundantly illustrated above. That such at least of the so-called conjunctions as name a relation between two thoughts should deal with that relation from the special view-point of self, is a foregone conclusion. In illustrating this, I must first make sure that your view-point is actually different from my own. Accordingly I imagine you to be a physician and myself a teacher. Of your patient, Brown, who is also my pupil, you say, following your medical tendencies: "He is ill; *for* he cannot study," deducing his illness from his mental incapacity, and putting the former in a sort of effect-to-cause relation with the latter. But I, as his teacher, following very different tendencies, may also say: "He is ill; *hence* he cannot study," deducing from his illness his mental incapacity, and putting the former in the cause-to-effect relation with the latter. That is, illness being our common point of departure

and incapacity our common point of arrival, from your viewpoint the latter is to the former a sort of cause, while from mine it is an effect. What to you is "for," to me is "hence" and vice versa.

The interjection may be merely extra-sentential, expressing irrelevant thought. In this activity, it obviously has the same egocentric opportunity as thought which is relevant. And when the interjection is strictly extra-linguistic, being almost a reflex cry, the associated emotion again may obviously be purely egocentric.

THEIR NON-PRONOMINALITY.

From what has occasionally appeared in this examination, it is obvious that a given word may be at the same time vicarious and an egocentric of the particular order now in mind. Thus, imitating the methods of the neo-Latin languages, suppose I say: "The house and the barn are mine. *That* (= the house) is of brick. *This* (= the barn) is of wood." In this sentence *"That"* and *"This"* respectively reinstate "the house" and "the barn." At the same time these reinstatives, being synonymous with "the former" and "the latter," distinguish their principals as the nearer and the further of thought, the thinking self of the moment being the landmark from which their nearness and remoteness are reckoned. While this simultaneous occurrence of different values is both familiar and far from difficult in itself, it is perhaps desirable, in view of Grammar's confusion, to emphasize their difference and their independence. Accordingly I note that in "That (meaning yonder schooner) is my yacht," "That" is fully egocentric, but without a trace of vicarious value. On the other hand in "Is your dog a collie? He is *that,*" I find in "that" a reinstative value, but nothing any longer consciously egocentric. When accordingly, in my example of the house and the barn, I find a "that" which is at the same time vicarious and egocentric, I see no occasion for embarrassment. Looking merely at the nature of the idea presented, I rank my "that" as egocentric or demonstrative. Looking at the method by which the idea is presented, I call my "that" vicarious or pronominal. But I call it egocentric because its idea is what it is, and vicarious because its idea

is presented as it is; I certainly do not call it vicarious from any peculiarity in the nature of its idea. Above all, it does not occur to me to argue that, because a vicarious word appears on this occasion to be also egocentric, the next time I meet a merely egocentric word I am to rank it as vicarious, and hence a pronoun. I am further not at all surprised that the same word may on occasion simultaneously rank in two categories; for no effort was made to render these categories mutually exclusive. The egocentric category is concerned with the formation of an idea in the mind. The vicarious category has to do with the idea's presentation by a word. The two are as irrelevant as the growing of wheat and the method of its shipment. The same grain may be at the same time of my raising, and sent to London by your steamer. But its production by me does not necessarily locate it in your vessel. So also the egocentric growth of an idea does not make its presentation vicarious. In other words, the special type of egocentricism known as demonstrative does not per se entitle an idea's presentation to rank as pronominal. That is, barring the expressional accident of vicarious presentation, the demonstratives are not pronouns in the sense of being vicarious. Their study is foreign to the field of Grammar, and belongs of right in the domain of Lexicology.

APPENDIX C—INDEFINITES.

THEIR NUMBER.

This is plainly vastly greater than Grammar indicates. Without attempting to complete what seems to me an idle beginning, I will merely suggest a few of the unrecognized indefinites. As point of departure note the following illustration: "In carving I reserved *something,* somewhat, somedel (del = Theil) for myself." In this sentence "something" is recognized by Grammar as an indefinite and ranked as a pronoun; (Conf. "etwas"). But for *"something"* I may substitute "part," "a portion," "a slice," etc., and this without essentially changing the corresponding idea, the method of its presentation, or the part which it plays in sentence-structure. "Someone," too, is hardly more indefinite than "John Doe" or his rival "Richard Roe;" and in "If *a body* meet *a body* comin' through the rye" we recognize the same familiar though dimly outlined physiognomy. In *"They* say *you* can't make *me* criminate *myself"* I use each one of the italicised words as fully the peer of "on" (French) or "Man" (German). The "Chose" and "Machine" (masc. "Machin") of French argot are quite analogous; and once without the pale of classic parlance we find a throng of "Fulanos," "Zutanos," "Thingumbobs," "What's-his-names," which may well diminish confidence in Grammar's effort to form the indefinite word-class.

THEIR VARIETY.

There are moreover other grounds for questioning Grammar's wisdom. Of indefiniteness there are several sorts. To illustrate, suppose I send you an oral message. It is plain that you may fail exactly to understand me, either by reason of my original inexactness, or through the inaccuracy of my messenger. Now in thought-communication my messengers are my

words. The indefiniteness of any idea which you receive may be the fault of either myself or my messenger, that is, my word. In the sentence "The post needs repairing," the word "post" is in a sense indefinite: you do not know whether I mean the Post Office or a hitching post. But my own original idea, though ambiguously expressed by "post," was entirely definite; and even the ideas, between which you are unable to choose, are entirely definite. Any existing indefiniteness characterizes the symbol and not the symbolized idea. It is better to call such symbols uncertain, ambiguous, or equivocal, reserving the term "indefinite" for ideas themselves.

The indefiniteness of ideas may be the result of different causes. In using the phrase "a group of men," I may be actuated by the fact that I do not know their number. Again it may be that what I perfectly know I do not care to tell.

Such indefiniteness may also be of different kinds. To illustrate, "Something lay in the darkness across my path." This "Something" answers the question "how many?" That is, it is numerically definite. The question "Of what kind?" it cannot answer, being valid, for instance, for a stone, a dog, or a fallen tree; that is, it is categorically indefinite. Nor can it answer the question "Which?" for, even if it specially suggested dogs, it would fail to indicate a particular individual; that is, it is selectively indefinite. "Man" (German) and "on" (French) are categorically definite but indefinite selectively and numerically. The same is true of "Some" in "Some men are virtuous."

Indefiniteness, moreover, varies in degree. "Some," in the notation of logic, is forced to cover every meaning from "one" to "all" inclusive. In actual practice, "some" includes neither "one" nor "all," but may include approximately any other number. "Several" is a good deal more restricted, standing, I should say, for never less than three and, at the most, for less than half of all. "Most" affects the upper; "many," a middle; and "few," a decidedly lower numerical range. Transitions even offer to the exactly definite. In "A dozen sprang to their feet," I should say that eleven and thirteen are contemplated possibilities. In "Twelve arose," it seems to me that

other numbers are positively excluded. In fact a sufficiently careful examination would doubtless here and there reveal a continuous series of ideas, in which the completest precision of which the mind is capable, would pass by imperceptible gradations into the utmost vagueness.

To draw a line of satisfactory demarcation between the definite and the indefinite would, accordingly, even in the single case of number, be quite embarrassing. Suppose, however, that such a line be satisfactorily established. Another line must be determined between the definite and the indefinite as to kind; and consistency requires that one such line should, so to speak, be abreast of the other—that both be equally far from the absolutely definite. But who will tell me whether the categorical indefiniteness of "something" is equal in degree to the numerical indefiniteness of "some" or the selective indefiniteness of "someone?" Or how shall I compare the spatial indefiniteness of "somewhere" with the temporal indefiniteness of "once upon a time?" Or what is my common unit for measuring the indefiniteness of what I know, as in "*Some* liked my dinner," and that of what I want to know, as in "*Who* are coming to dinner?"

THEIR SENTENTIAL RANK.

Their use as nouns appears in the following sentences: "*People* say *one* should not praise himself." "*They* say *much, little, numbers* of things." "For *aught* I know they say *any thing.*" "If you don't go *it* with all your might, *it* will go hard with you; *it* is raining already." "Who is *it?*" (in the phraseology of children's games.) Among the virtual indefinite numerals I should rank, besides those already noted, flock, bunch, herd, drove, bevy, flight, school, crowd, party, constellation, swarm, shoal, covey, cloud, etc. In the quantitative field I find, beside such definites as inch, foot, yard (linear, square or cubic), a throng of indefinites, for instance, mass, batch, heap, deal, lot, morsel, sip, sprinkling, dash, taste, etc.

Their adjective function, as in "*Some* animals are men," has been amply illustrated. Of this indefinite adjective plural, the so-called indefinite article is merely the nearest possible singu-

lar. "Some," which is indefinite as to individuals and number,[1] becomes of necessity definite in number, in order to be a singular. It is by the merest accident that English has developed the special "a" or "an" for indefiniteness of the singular number. The actual correlation of "a" and "some" is shown by the Spanish "uno," "unos," etc. Moreover, when numerical degree is displaced by degree of bulk, as happens in the case of mass-words, the range of degrees expressed by singular "a" and plural "some," is covered by a "some," itself now singular, as in "some flour," "some powder," etc.

The true significance of the indefinite article is shown by languages possessing more than two numerical inflections. In such languages the noun occasionally offers inflectional series of the following values: "one man," "two men," "three men," "four men," (more than four or) "many men." All these forms are indefinite in selection, but the last alone in number. Whether now the numerical elements be expressed by separate adjectives, or incorporated in the nouns by inflection, the value of the series is the same. According to the point of view it may be claimed, with prior attention to number, that "one" is the singular of "two," "three," "four" and "many," that is, three definite plurals and one indefinite. Or, with prior attention to numerical definiteness, "many" may be ranked as the indefinite corresponding to four definites, of which one is singular and the others plural. Or, with exclusive and closer attention to number, the successive forms may be known as Grammar knows them, namely, as singular, dual, trial, quatrial and *plus* quam quatrial or *plural.*

The adverbial indefinites present a categorical range of unusual interest. The "somewhere" of space becomes, by an easy transition, the "sometime" of temporal position. This, moreover, leads readily to the "somehow" of manner, which again becomes a word of indefinite cause, as in "Somehow I fell." Such indefiniteness of kind is paralleled by indefiniteness of degree, as in "Somewhat uncommon," "Rather unusual," etc.

A tendency at least to verbal indefinites appears in the excessive range of meanings employed with "to get," a phenomenon

[1] Category it renounces in favor of its accompanying noun.

by no means peculiar to bad English, but duplicated, more or less exactly, throughout the range of language.

The use of strictly indefinite conjunctions, especially those distinguished as thought-connectives, is notoriously the stumbling block of many writers.

The interjections, meaning now particularly the words for emotion, are frequently of the most non-committal type.

The indefinite preposition is specially interesting as showing with special clearness the occasional indefiniteness of even the simplest relations. To illustrate, the relation expressed by "at" in "at the intersection of two streets," while definite enough perhaps with respect to distance, is quite indefinite as to bearing (see p. 129). I may for instance have in mind a house *on* either corner, an electric light *above* the central line of either street, or a cistern directly *below*. Again the extremely variable "of," in some of its uses, seems to be as completely indefinite as any element of speech. In "The things *of* this life," I can hardly define the "of" as standing, even to my own mind, for anything more special than "related to in any way."

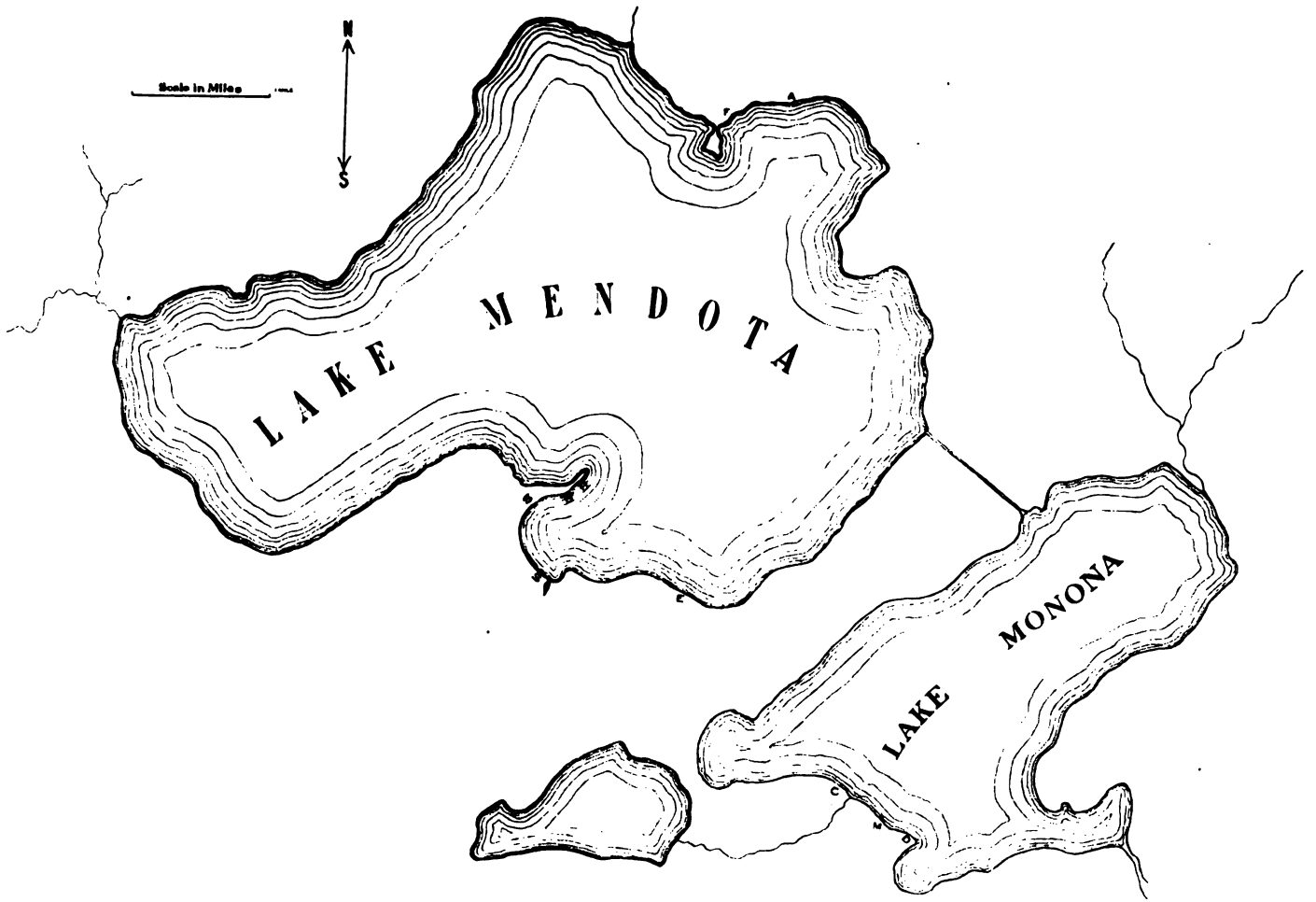
THEIR NON-PRONOMINALITY.

By this caption I invite the question: Can the indefinite be also a pronoun, or, can a single word be not only indefinite, but also vicarious? That it can, is to my own mind so nearly axiomitic as to invite no comment. But, to make sure of the matter, suppose, in illustration, "I bring you a box of roses. *Some* are red and others are white." In this sentence "Some" is no doubt indefinite; but it is also reinstative (vicarious): it revives in mind a part of an idea already expressed by "roses," but meantime allowed to lapse; and in the present usage it is helpless without its principal.

The fact, however, that the same word is at the same time vicarious and indefinite, should hardly entail confusion of these attributes. The case is merely parallel to that of personals (p. 127) and that of demonstratives (p. 134). It does not even suggest that what is indefinite should therefore be ranked as also pronominal. Accordingly I deny that indefinites are pronouns, meaning that mere indefiniteness does not constitute pro-

nominality. That is, indefinites, so far as they are merely such, must be ranked as pseudopronouns; in other words they are not pronouns, except so far as they may claim the pronominal rank by virtue of something more than their indefiniteness.

Madison, Wis., January, 1900.



Outline Map of Lakes Mendota and Monona.

ICE RAMPARTS.

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The diurnal and weekly changes of temperature during the winter months cause a sufficient expansion and contraction of the ice covering the inland lakes of Wisconsin to shove up the sand, gravel, boulders, and sod along the shores into peculiar ridges, known as ice ramparts. These ridges are of various shapes and sizes, but ordinarily the longer direction extends approximately parallel to the shore. The ridges are discontinuous, of variable length, and range from a fraction of a foot to several feet, in height. Observations have shown that they are not ordinarily an accompaniment of *very small or very large lakes,* although their formation is not entirely controlled by the size of the lakes, depending in the region under discussion mainly upon the prevailing climatic conditions. In this state the temperature conditions are such that the formation of ice ramparts is limited to lakes of moderate size, and they are best developed during seasons when the snow-fall is very light.

During the winter of 1898–99 the precipitation and temperature conditions in south central Wisconsin were exceptionally favorable to the formation of ice ramparts by the moderate sized lakes. During this season ridges were shoved up at many places along the shores of different lakes in this region.

The ice ramparts which attracted the special attention of the author were formed along the shores of Lakes Mendota and Monona. These lakes are located in the south central part of Wisconsin, immediately adjacent to the city of Madison. The general shape and outline of the lakes are shown in Plate I. Lake Mendota has an area of 15.2 square miles, and the area of Lake Monona is about 3.9 square miles. The volume of water in Lake Mendota is roughly 16,880,000 cubic feet; that of Lake Monona is very much less. The coast line of both lakes

is irregular. In some places the lakes are bordered by low swamp lands, while at other places the land juts out into the lake, forming vertical, or nearly vertical escarpments, thirty or forty feet in height. The bank is in some places vertical, or even overhanging, while in other places it slopes very gradually to the lake. The banks of the lakes consist of horizontal beds of limestone and sandstone, sand and gravel, boulder clay, and marly ooze and weeds which pass shoreward into marsh-grass meadow-land. At many places the banks are covered with trees down to the water's edge. This great variety of shore conditions furnishes a corresponding variety in the shape of the ice ramparts, resulting from the shoving of the ice.

According to the records of the Madison Democrat,[1] Lake Mendota closed on the 7th day of December, 1898, while Lake Monona remained open until the 12th. During the winter which followed very little snow fell in the region under consideration, and during a greater part of the season the ice on the lakes was bare. The temperature changes during the months of December, January, and February were very great, as is shown by the accompanying table, which was compiled from the records of the Washburn Observatory. The season was one of alternating warm and cold spells. Several warm spells were followed by periods of intense cold; the changes being very rapid and extreme for this region. During three days of the latter part of December, the thermometer fell 54° F., or from +42° to —12°; during four days in the latter part of January, the temperature changed 55° F., falling from +30° on the 26th to —25° on the 29th; from the 12th to the 15th of February the temperature changed 61°, rising from —30° on the former day to +31° on the latter. Many other temperature changes occurred during this period but these were the most marked.

[1] This record is taken as authority because it corresponds with observations made by the author.

XIII.

Plate II.

TABLE I.— *Maximum and minimum temperatures during the months of December, 1898, January, 1899, and February, 1899.*

In degrees Fahrenheit.

DATE.	DECEMBER, 1898.			JANUARY, 1899.			FEBRUARY, 1899.		
	Max.	Min.	Dif.	Max.	Min.	Dif.	Max.	Min.	Dif.
1	26	16	12	11	—9	20	11	—4	15
2	24	12	12	28	8	20	8	—5	13
3	24	14	10	39	21	18	8	—4.5	12.5
4	18	7	11	40	8	32	5	—8	13
5	20	4	16	16	1	15	5	—9	14
6	22	15	7	16	2	14	5	—5	10
7	18	5	13	10	—6	16	2	—13	15
8	9	—2	11	10	—6	16	2	—13	15
9	10	—5	15	16	6	10	—15	—27.5	12.5
10	20	1	19	25	8	17	—5	—25	20
11	29	15	14	28	15	13	—6	—18	12
12	22	—8	14	34	19	15	0	—23	23
13	8	—2	10	36	31	5	13	—10	23
14	20	—5	25	36	25	11	20	3	17
15	24	5	19	37	26	11	38	19	19
16	30	16	14	36	23	13	44	26	18
17	33	16	17	30	16	14	44	33	11
18	33	21	12	25	7	18	39	26	13
19	33	24	9	32	14	18	42	28	14
20	33	29	4	35	24	11	49	37	12
21	33	30	3	36	28	8	41	32	9
22	33	26	7	34	21	13	36	27	9
23	29	20	9	32	24	8	28	12	16
24	22	8	14	25	13	12	21	0	21
25	21	9	12	35	12	23	32	15	17
26	32	11	21	35	1	34	36	17	19
27	32	6	26	11	—10	21	23	0	23
28	31	6	25	12	—13	25	29	11	18
29	42	30	12	—2	—20	18	Total snow fall 5 inches. Very little on ground at any one time.		
30	34	—5	39	1	—16.5	17.5			
31	1	—12	13	4	—16	20			

During the periods of low temperature the ice increased in thickness until it attained a maximum of from thirty to forty inches. Shallow portions of the lakes were frozen to the bottom, and in many of the especially shallow places the bottoms of the lakes were frozen beneath the ice.

Turning our attention from the conditions prevailing at that time to the resultant shore phenomena, we distinguish three different forms of ice ramparts, which depend for their peculiarities largely upon the size, shape, and composition of the bank. The first kind occurs along a sand or gravel beach of gradual slope; the second kind occurs along an abrupt shore, adjacent to which the water is somewhat deep; and the third kind forms at the head of bays where the shore is low, marshy meadow-land, adjacent to which the bottom of the lake is composed of mud, marl, and weeds. There are all gradations between these forms.

Examples of the first kind were observed at many favorable places along the shore of both Mendota and Monona. In many of the especially shallow places, as stated above, the bottom of the lakes had frozen to a considerable depth below the water. During the periods of expansion the frozen lake bottom, consisting of boulders, pebbles, and sand, together with the ice sheet above, to which it was welded, was shoved up the gradual incline of the beach. The boulders, pebbles, and sand composing the lake bottom maintained the same relative positions which they had before they were moved, and when the ice melted later in the season the boulders, pebbles, and sand were left as a thin mantle, often extending six or eight feet beyond and above the edge of the water. (See Plate II.) The best example of this phenomenon was observed along the beach an eighth of a mile east of the Mendota Hospital for the Insane. (See A, Plate I.) The same was also observed along the southeast side of Picnic Point (See B, Plate I), and at one or two places along the south shore of Lake Monona. (See C, Plate I.)

The second form of the ice rampart occurred where the shore line was abrupt, forming steep banks of variable height. The result of the ice shoving against such banks depends upon the thickness of the ice and the character and composition of the shore. In some places the bank was uninjured by the ice-shove, relief taking place by the breaking up of the ice near or at some

Ice ridge formed out from but near the shore on Lake Mendota.

distance from the shore. Where this occurred, the ice was ordinarily piled up in irregular blocks forming what is commonly known as an ice ridge. (See Plate III.) In some places the relief occurred near the shore, on account of which the bank was nearly covered with a mass of broken ice. In this way, boulders, which were originally at, or even below the surface of the water, were carried upward and deposited on the top of the bank, where they frequently remained as perched blocks after the ice had melted in the spring. The best illustration of this phenomenon occurred along the south shore of Lake Monona, where a heavy bank of glacial boulders effectually resisted the pressure of the ice. (See D, Plate I.) Similar examples were conspicuous along the shore of Lake Mendota bordering the University grounds (See E, Plate I.), and also along the steeper and more resistant portions of Picnic Point.

In some places the expansion of the ice resulted in elevating and pushing over almost vertical banks of boulder clay. The most striking examples of this phenomenon occurred on Lake Mendota at Picnic Point and in front of the Mendota Hospital for the Insane. The bank on the east side of Picnic Point (See R, Plate I.), composed of sod, boulders, and clay, was shoved up into a ridge having an average height of about four feet, a breadth of base of about eleven feet, and a breadth at the top of about four feet. At one place the bank had a height of not less than eight feet and carried on the top a tree of considerable size. (See Plate IV.) In many places the ice-shove was made more effective by numerous boulders and large quantities of gravel which had been caught up and frozen into the ice along the shore. These boulders were in many places actually rammed into the bank, where they presented much the appearance of plums in a pudding. A larger part of the rampart on Picnic Point was nearly vertical, although in one or two places it had been partly overturned.

The shore of Lake Mendota in front of the Hospital for the Insane is bordered close to the water's edge with many trees. (See F, Plate I.) The bank is in many places vertical or even over-hanging and large masses were raised up and overturned by the ice-shove. Trees twelve inches and more in diameter were dislodged and overturned. (See Plate VII.) In one place,

the sod covering the ground between the lake and a small lagoon, a distance of about twenty feet, was dislodged throughout the entire distance by the force of the ice-shove. (See Plate VIII.) The main ridge which was formed at this place had a height of from three to five feet, but was not as continuous as the one which occurred on Picnic Point.

This same form of rampart was observed along the shore of Lake Monona. In a number of instances on this lake the ice froze back under the bank and when the ice-shove came large blocks of sod, carrying trees and underbrush, were elevated and displaced. At other places the bank was torn up, forming ridges resembling the one at Picnic Point. East of the assembly grounds (See M, Plate I) the sand forming the beach was piled up in a long symmetrical ridge, as shown in Plate IX.

In several places on Lake Mendota the ice came in contact with small cliffs of sandstone and limestone, and in two of these instances fragments of considerable size were broken off by the ice-shove.

The third kind of ice rampart has the shape of more or less symmetrical folds, which always occur near the shore, where the water is shallow. As previously stated, the bottom of the lake consisting of mud, marl, moss, and weeds, was frozen in the very shallow places to a considerable depth below the ice. Where the bank was abrupt, the folds were formed out from the shore, but where the shore passed by a gradual slope into marsh-land, the folds were formed on the landward side of the lake. In several places where the lakeward and landward conditions were balanced the folds formed on both sides of the shore line. Where the above conditions prevailed there was formed either a single fold or a series of consecutive folds resembling the Appalachian Mountain structure.

The most characteristic and best defined folds of this class occurred along the shores of University Bay on Lake Mendota. (See S, Plate I.) The folds at this place were developed on two sides of the bay. The expansion of the ice apparently resolved itself into two components acting approximately at right angles to each other, on account of which the longer axes of the folds on the two sides of the bay were nearly normal to each other. The positions of several of the folds are shown on a small scale in Plate X.

Lakeward side of the ice rampart on Picnic Point. Shows an overturned tree and numerous boulders rammed into the shore by the ice shove.

Beginning at the east end of the bay, a single fold was developed which extended uninterruptedly for a distance of one hundred yards. Twenty-five yards from the west end of this fold two other folds were formed, parallel to the first. These were normal folds, having limbs dipping at angles of 71° south and 50° north. The largest of these folds, of which one-half was destroyed by a sharp re-entrant angle, is shown in Plate XI. The radius of this fold was five feet, and the length of the portion, which is shown in the figure, measured fifty feet. When first observed the fold was normal; but later in the season it became slightly overturned, as shown in the illustration. The dip of the south limb was 73° south, and that of the north limb 55° north. The arch was hollow, and the limbs had a thickness of about twelve or fifteen inches.

The main fold continued west for about 375 paces and then died out. Near the middle of this fold, and outside of it, a second fold was developed, which had a length of about thirty-five or forty yards. At the east end, these folds were so near together that they almost coalesced. Toward the west they diverged until they were about fifteen feet apart, measured from crest to crest. The small outer ridge was normal, each of the limbs being symmetrical with respect to the axial plane. The fold nearest the shore was overthrust at the east end, having limbs dipping 49° north and 79° north. As it was followed west, the form changed until it had the characters of a normal and then of an underthrust fold. That portion of the fold which was parallel and adjacent to the second fold was normal, having limbs which dipped, respectively, 85° north and 50° south. The limbs of the underthrust portion of the fold dipped respectively, 65° south and 50° south, also 55° south and 75° south. The limbs of the overthrust portion at the west end dipped, respectively, 55° north and 75° north. The prominent underthrust and overthrust sections of the main fold each continued for a distance of about fifty feet.

The main fold was fractured along the entire length of its crest, while numerous less conspicuous fractures occurred across the fold at various intervals throughout its entire length. These fractures were all so sharply defined that they had much the appearance of having been cut with a huge knife.

The best developed folds were formed on the west side of the bay and are illustrated in Plate X. (See also S, Plate I.) Twenty-seven distinct and separate folds were formed at this place. Fifteen of these appeared to be successive, one being outside of the other. The size of the folds, and the distance of those along the south half of the shore from one another, are given in Table II.

TABLE II.

No. of fold.	Length of axis.	Length of radius	Maximum breadth of base.	Distance from crest of one fold to crest of next.	Remarks.
	Feet.	Feet.	Feet.	Feet.	
1	26	3	2	3	
2	24	3	3	5	Isoclinal with steep limbs.
3	68	3	3	4	Underthrust at north end, otherwise normal.
4	30	2	5	9	Axes of this and most of folds are sinuous.
5	57	2½	2½	3	Underthrust.
6	40	2½	4	7	Faulted across. On one side of fault, isoclinal, on other side, underthrust.
7	35	2½	3	9	Normal, approaching isoclinal.
8	52	2½	7	11	Normal—faulted near middle. Throw of 7 feet.
9	53	2½	4	6	Double curve in the axis.
10	30	2	2	10	Nearly isoclinal.
11	17	1½	2	6	Normal—slightly faulted.
12	22	1½	3	5	Normal—slightly faulted.
13	19	2	1½	4	Isoclinal—limbs about vertical.
14	13	1	2½	26	Small arch.
15	43	2	3-4	....	Discontinuous along shore
16	15	3	4	.....	Double curve in axis.
17	27	3	6		
18	46	4	3½	.....	Overthrust.
19	67	4	4	....	Overthrust.
20	72	3	2	.....	Isoclinal.
21	20	2½	3½		
22	23	2½	3½		
23	14	2½	3½	.....	Broken arch.
24	26	2½	3½		
25	34	2½	3½	....	Broken at top.
26	20	2½	3½	.....	Broken at top.
27	50	2½	3½	.....	Broken at top.

FIG. 1.
View of ice rampart on Picnic Point from the shoreward side.

FIG. 2.
A close view of the ice rampart shown in Fig. 1.

The limbs of these folds dipped in various directions, and at different angles. The limbs of one of the folds dipped respectively 38° west and 38° east; the limbs of another dipped 65° west and 78° west, and a third had limbs which dipped 70° east and 60° east. In this small area all classes of folds were represented, normal, overthrust, and underthrust. Each of the folds was sharply fissured nearly the entire length of its axis. Cross-fractures were of common occurrence, and in a number of instances they were accompanied by conspicuous faulting, as shown in Plate XII. In this instance the fold has parted in the middle, one-half having moved horizontally past the other. Faulting had also occurred along the crest parallel to the axis but the movement between the limbs was not very great. In many instances the fractures were open and the walls had separated for a space of one or more inches. Many of the arches were hollow, although some appeared to have very little vacant space between the limbs. Some of the folds died out gradually at the ends, but in many cases their termination was quite abrupt.

It was evident that the anticlines had risen much more than the synclines had been depressed. In fact the synclines had, in only a few places, the appearance of having been depressed below their former level.

It was observed at this locality, and elsewhere, that the character of the folds and the rigidity of the shore line were closely related to each other. Wherever the folds were near a rigid shore line they were almost invariably overthrust. Where the rigid bank was absent, or distant, the folds were generally normal or underthrust. These relations existing between the bank and the folds were observed in a sufficient number of places along the shore of both lakes, to show the interdependence of the two.

CAUSE OF ICE RAMPARTS.

The cause of ice ramparts as expounded by G. K. Gilbert in his classical monograph on Lake Bonneville, is well known to all students of geology. It is as follows:

"The ice on the surface of a lake expands while forming, so as to crowd its edge against the shore. A further lowering of temperature produces contraction, and this ordinarily results in

the opening of vertical fissures. These admit the water from below, and by the freezing of that water they are filled, so that when expansion follows a subsequent rise of temperature, the ice cannot assume its original position. It consequently increases its total area and exerts a second thrust upon the shore. Where the shore is abrupt, the ice itself yields, either by crushing at the margin or by the formation of anticlinals elsewhere; but if the shore is generally shelving, the margin of the ice is forced up the acclivity, and carries with it any boulders or other loose material about which it may have frozen. A second lowering of temperature does not withdraw the protruded ice margin, but initiates other cracks and leads to a repetition of the shoreward thrust. The process is repeated from time to time during the winter, but ceases with the melting of the ice in the spring."

This explanation is the best and most satisfactory of any I have yet read. However, the observations made during the last two seasons have added a number of interesting details, especially concerning the manner in which the ice behaves while producing these striking shore phenomena, which it may be profitable to discuss in the succeeding pages.

The entire phenomenon of ice ramparts depends upon the expansion and contraction of the ice sheet resulting from abnormal fluctuations in the temperature of the ice. The deformation of the ice sheet itself is a much more complicated story than the formation of the ice rampart. The ramparts which form along the shore are only the more striking manifestations of the forces resulting from changes in the temperature of the ice. They occur only under exceptionally favorable conditions, while the deformation of the ice sheet as a result of the same agency occurs each winter.

At a temperature of 39° F. water is at its maximum density. An increase or decrease in its temperature results in expansion. When the temperature of water is lowered to 32° F. it solidifies, and if free to move, linear contraction sets in at the rate of about $\frac{1}{10000}$ for each degree centigrade or $\frac{1}{18000}$ for each degree Fahrenheit.[1] If the ice is not free to move the tensile stresses will ac-

[1] As determined by Struve, the linear coefficient of expansion is .000053 for each degree centigrade.—See Poggendorffs Annalen; Vol. 66, p. 233. Edward S. Nichols obtained nearly the same result. See Phys. Rev. Vol. 8, pp. 184-186.

Overturned trees along shore of Lake Mendota, in front of the Hospital for the Insane.

FIG. 1.

FIG. 2.

Trees dislodged by the ice shove along the shore of Lake Mendota in front of the Hospita for the Insane.

cumulate until the limit of elasticity is reached, when relief will take place. Whenever the temperature of the ice is increased or decreased forces will be set up tending to either expand or contract the ice at the rate above given.

During the month of February, 1900, the temperature of the ice at different depths from the surface was obtained by using a thermometer especially adapted for the purpose. Unfortunately I was able to obtain only five sets of observations. These indicate that the temperature of the ice at the surface, when uncovered with snow, is about that of the atmosphere up to zero centigrade, while it increases almost uniformly with the depth, until the lower surface is reached, where the temperature is that of unfrozen water.[1] From the observations taken, it appears that the mean temperature of the ice is about midway between the upper and lower surfaces and this can be taken as the average temperature of the ice sheet as a whole.

As stated above the tensile stresses result from a lowering temperature. These stresses are a maximum at the surface and decrease with the increase in temperature as the under surface of the ice is approached. The tensile stresses will be the same for each unit of area in any one plane parallel to the surface and different for every other plane. Each unit of a plane normal to the surface, except those occurring in the same horizontal plane as above stated, will have stresses of different values. That is to say, the tensile stresses are greatest at the surface and decrease toward the under surface of the ice sheet. If free to move, the ice sheet would contract in all directions *pari passu* with any decrease in temperature. However, the margin of the ice sheet is attached to the shore in such a manner that immediate contraction can only take place normal to the surface of the ice sheet. The ice particles are free to move normal to the surface of the sheet and the stresses in this direction, occasioned by a lowering of the temperature, are immediately relieved by the particles moving closer together. The contraction resulting from stresses in this direction would not exceed one-twenty-fourth of an inch for a thickness of thirty-five inches and a fall

[1] I expect during another season to obtain a continuous series of observations which will more fully demonstrate these conditions.

of 49° F. in the temperature. This amount is so small that it will not need further consideration.

The tensile stresses in the horizontal directions accumulate until one or the other overcomes the strength of the ice and cracks form. As stated before, the tensile stresses are greatest at the surface and rupture will begin when these stresses overcome the strength of the ice at this place. When once started, the cracks will continue either part way or entirely through the thickness of the ice.

The linear contraction of a field of ice four miles wide, provided movement took place with perfect freedom, would be 0.586 feet for each degree F. In a case similar to the one under discussion, where the temperature of the surface layer is hypothetically lowered 49° F., the contraction of this layer would be 28.714 feet. On the other hand the layer next to the water having a temperature of 32° F. would suffer no contraction.

Cracks that are once formed often open again and again, but each time they reach the under surface of the ice they fill with water. The water rises about nine-tenths of the way to the surface and there solidifies. (See Plate XVII.) As the ice increases in thickness it is buoyed up higher and higher, on account of which the water in the cracks rises successively to a point which is further from the surface. Each time the cracks fill, the water is at a lower level. When it freezes, steps like terraces are formed from the center to the margin of the vein.

During the entire period of lowering temperature, the ice sheet increases in thickness by the solidification of the water at the lower surface. It also increases in density through contraction. The amount of horizontal contraction is about equivalent to the volume of new ice which fills the cracks that show at the surface. As the ice sheet increases in volume it is buoyed up by the water, increasing its general level. This increase in volume comes at a time when contraction is at a maximum and may affect more or less the results.

The water which fills the cracks expands when it freezes, resulting in inducing compressive stresses which neutralize in part the subsequent contraction.

When the temperature has reached the lowest point the ice sheet is a solid mass filling the entire lake basin. When the

Dislodgment of ground between Lake Mendota and a small lagoon in front of the Hospital for the Insane.

FIG. 1.
Ridge of sand formed on shore of Lake Monona by the ice shove.

FIG. 2.
A near view of ridge shown in Fig. 1.

temperature begins to rise compressive stresses are set up, which, as in the case of the tensile stresses, are greatest at the upper surface of the ice sheet, where the rise in temperature is greatest. They are absent at the lower surface where the temperature is constant. These stresses find immediate relief only normal to the surface of the ice. The horizontal stresses occasioned by the expansive force of the molecules accumulate until they are powerful enough to overcome either the rigidity of the ice and the tensile strength of the lower layers of ice, or the rigidity of the bank and the tensile strength of the lower layers.

The enormous force with which water expands when passing from a liquid to a solid state is well known, but must not be confused with the force of expansion of ice due to a rising temperature. If the force in the case of freezing water and rising temperatures can be said to be proportional to expansion, then the force exerted by water upon freezing will be 666 times the expansive force of ice when raised 1° F. In other words it would require a change of 666° F. in the temperature of the ice, to make the expansion caused thereby equal to that of the same volume of water in passing from a liquid to a solid state.

If the rigidity of the banks is greater than that of the ice cap relief will take place by the bulging or arching up of the latter. If the banks are weaker than the ice cap, ramparts will form along the shore. The initial relief usually takes place suddenly, as shown by observations on Lake Mendota. Ice ridges have been known to form instantaneously on this lake, with a report and shock resembling a miniature earthquake. After the ridge or rampart has once formed relief takes place *pari passu* with the compressive stresses. When the relief is once initiated it requires but little force to keep the mass moving.

Owing to the greater compressive stresses in the upper than in the lower layers of the ice sheet, when expansion takes place, tensile stresses are set up in the latter which must overcome the strength of these layers before relief can take place in any manner. When the compressive stresses are powerful enough to overcome the strength of these lower layers, as well as the rigidity of the ice sheet or bank, relief takes place in the lower layers, through the formation of cracks which begin at the under surface and extend upwards. (See Plate XIV.) These cracks

from the under surface are always formed during a rising temperature, and are in respect to form similar to those which form from the upper surface downward during a period of falling temperatures.

When cracks form from the lower surface the unfrozen water soon fills the spaces thus formed. If the temperature is still one of freezing or if it soon changes from thawing to freezing, this water will solidify, making the ice cap solid again from bank to bank.

In general, all cracks, whether they form from the upper or under surface, may be divided into two classes. The first consists of those that penetrate the entire thickness of the ice and the second comprises those that penetrate only part way. The cracks of the first class often extend in straight lines over long distances. Those of the second class are mainly short and discontinuous, and often form a veritable net work. The cracks of the first class are shown in Plate XV, and those of the second class in Plate XIV.

The stresses on the ice sheet are very complex and the fissures which result extend in many directions and are indefinite in length. The fractures are frequently very complex, resembling the spiral or feather structure shown in Plate XVI. Short cracks, not over two or three inches long, were frequently observed crossing the larger fractures at right angles. Where an especially prominent fracture has formed it is common to find several less important ones near by and parallel to it.

A number of cracks were observed in which the walls at the surface were one-fourth inch apart, and yet which apparently had not been filled with water from below, the ice being about fourteen inches thick. Most cracks at the surface of less width than this, however, were filled with ice.

The theory that contraction is a maximum at the upper surface and a minimum at the under surface leads to the assumption that the ice filling a crack which forms from the upper surface will have the shape of a wedge as shown in Plate XVII. The ice filling a crack which forms from the under surface will likewise have the same shape, except that the head will be down instead of up.

An examination of a considerable number of ice cracks dur-

Bird's-eye view of the folded area on the northwest side of University Bay.

Half of a fold formed on the south side of University Bay, Lake Mendota.

ing a period of lowering temperature neither corroborated nor disproved this theory, on account of the difficulty in delineating the boundaries between the old and the new ice. By means of the lamination, which shows at the surface, the veins could be traced about half way through the ice sheet, but at that depth they were always lost. The shaded portion of Plate XVII represents that portion of the vein that could be delineated. However, I am very certain that this does not represent the total area of new ice. The lamination which extends to this depth is probably due to very fine cracks caused by differential contraction which is constantly operating during falling temperatures. During a rise in temperature the ice veins can scarcely be delineated to any depth below the surface. Apparently the compressive stresses resulting from the rising temperature obliterate by regelation the fine cracks formed by tensile stresses during the time of lowering temperature.

The actual movement of the ice sheet is further shown by faults, which may have either a horizontal or vertical displacement. When relief takes place by the formation of ramparts along the shore horizontal displacement takes place in the ice sheet. When relief takes place by the arching up of the ice sheet, both vertical and horizontal displacements result. Plate XVIII. shows a fault with a horizontal displacement of about two feet. The crack which formed normal to the first one and along which the displacement occurred, as shown in the illustration, may have been initiated prior to the time of expansion, or it may have resulted from the expansion of the ice at the time of relief. The displacement of two feet in the above illustration is evidence that a corresponding relief must have taken place, either by bowing up of the ice at another place, or by the formation of ramparts along the shore.

In the detection of faults in ice, as in rocks, one may easily be led astray by other phenomena which have all the appearance of faults. It often happens that a crack will terminate abruptly against another cross fracture and continue again on the other side at a distance of from two inches to two feet from the place where it terminates. Numerous secondary cracks are frequently observed to end abruptly against one of larger size.

The most complex fracturing and faulting occurs when relief

from expansion comes in the shape of a bowing up of the ice. The ice sheet breaks either at a place where it is weakest or where for some other reason it is arched before expansion begins. Contraction, however, precedes expansion, and it has been observed that where the ice ridges occur, there the widest cracks have previously been opened. The ice shove which accompanies expansion often elevates the ice to a height of eight or ten feet, in consequence of which the ice sheet on either side is depressed. Through the cracks in the synclinals thus formed water flows out at the surface, forming lakelets which have been observed 150 feet long by 75 feet wide and eight or ten inches deep. When the temperature changes, the water of these lakelets freezes, resulting in a thickening of the ice at this place. It has been observed that during alternating warm and cold periods the ice ridges do not form at the same place. This is probably due to the thickening of the ice at the place where each successive ridge is formed, as above noted. The increased thickness adds to the strength and rigidity of the ice at such places, and at the next shove the ridge forms where the ice is weaker. This change in the location of the ice crack on Lake Mendota occurred three or four times during the winter of 1899 and 1900.

The analogy between the deformation of a sheet of ice covering a lake and that of the crust of the earth is in some respects very striking. The deformation in both instances is by both tensile and compressive stresses, although the more marked deformation is due to horizontal compressive stresses. The results of the expansion and contraction are in both cases very nearly alike, representing a region in which movement takes place by combined fracture and flowage. Faulting, folding, jointing, and the welling up of liquid material from below through cracks are phenomena common to both. In the case of the ice sheet the student has the advantage of watching these phenomena and noting their peculiarities. The cause is also definitely known and the observer can measure relatively the forces which are operating.

In conclusion I will briefly summarize the changes involved in the process of ice rampart formation.

The 1st condition is one of lowering temperature owing to which the water of the lake freezes.

A fold which has been faulted by the unequal shoving of the ice.

Crack showing partial fault and also depth below the surface of the ice sheet to which the water rises before solidifying.

2nd condition.—Lake covered with the ice sheet and temperature still falling. Result:—Ice thickens below, raising upper surface. Tensile stresses are set up, on account of which cracks form at surface. The openings thus made penetrate through the thickness of the ice and they are filled with water from below, which soon freezes. The cracks open repeatedly until the temperature reaches its lowest point. The ice sheet is then approximately adjusted, at the minimum temperature, to the size of the lake basin.

3rd condition.—Temperature of ice rises. Result:—Compressive stresses are set up, which cause the ice to expand. The relief comes either through the formation of ridges in the ice sheet, or the formation of ice ramparts along the shore. Cracks also form from the under surface of the ice.

4th condition.—Freezing temperature. Result.—Water wells up into the cracks and freezes. Ice sheet becomes a solid mass as before approximately adjusted to the size of the basin.

This completes the cycle of changes in the ice due to variations of temperature.

Madison, Wis., January, 1900.

DISCUSSION.

BY PROFESSOR C. R. VAN HISE.

Dr. Buckley's paper upon the behavior of expanding and contracting ice and the resulting deformation of ice and shore is of very considerable geological interest, because of the many analogies that the phenomena present to the crustal deformation of the earth. Many experiments have been made in the laboratory with various materials, the aim being to reproduce on a small scale the phenomena of crustal deformation, in order that inferences might be made as to the nature of the forces which produced the phenomena. Laboratory experiments simulating the phenomena of crustal deformation date back as far as Hall,[1] the contemporary of Hutton. The much later experimental work of Daubrée[2] is well known. In the last few years a number of men have been working upon the problem in the laboratory. Notable among these are Willis[3] and Prinz.[4]

The shore and ice deformation caused by ice expansion described by Dr. Buckley stimulates more nearly many of the phenomena of crustal deformation than have laboratory experiments. Moreover the phenomena are on a much larger scale and are of correspondingly greater value in judging of the manner in which the phenomena of crustal deformation are produced. Dr. Buckley's work is of especial interest to me since the phenomena described by him almost exactly illustrate a number of the phenomena which I have elsewhere discussed. These will be separately mentioned.

First is the manner in which normal folds pass into overturned folds. It has been supposed in such cases that the thrusts have come "more largely from one direction than from the other, and the axial planes of the folds have usually been

[1] Sir James Hall: Trans. Roy. Soc. Edinburgh, Vol. VI, 1805.

[2] Géologie Experimentale, by A. Daubrée: Vols. I and II, 1879.

[3] The Mechanics of Appalachian Structure, by Bailey Willis: Thirteenth Ann. Rept., U. S. Geol. Surv., Pt. II, 1893, pp. 211-281.

[4] L'Echelle Reduite des Experiences Géologiques, by W. Prinz: Revue de l'Univ. de Bruxelles, Tome II, 1896-97, p. 47. Bull. Soc. Belge d' Astronomie, 1899, p. 70.

FIG. 1.

FIG. 2.

Cracks in the ice. The ribbon like cracks have formed from the under surface and only extend half way through the sheet.

Cracks in the ice. Mainly of the first order.

regarded as dipping toward the force." [1] Such folds are overthrust folds. The reason that overthrust rather than underthrust folds commonly form is that the direction of easiest relief is upward rather than downward.[2] That is the manner in which the forces have acted, as shown by Dr. Buckley, in the case of a majority of the overturned folds described by him. He observes in reference to the folds along the shore that "wherever the folds were near a high shore line they were almost invariably overthrust."

Another point of great interest is the successive development of folds formed along marshy shores. I have explained that parallel folds in the earth's crust are probably successive. As a result of the formation of the first fold the strata are piled up and thickened. "After a time the increased thickness of material is sufficient to present a larger total resistance to deformation than the thinner strata in advance. The stress will then be transmitted forward. On account of the greater stress per unit of area, a second fold similar to the first will then be formed, but this results in again thickening the mass subject to the force couple, and again the stress is transmitted forward. A new inclined fold is then produced, and so on."[3] While parallel folds are largely successive, one fold does not completely develop before the next begins to form. This sequence inferred for mountains a number of years ago is exactly paralleled by the manner in which the folds formed in the soft marsh as described by Dr. Buckley.

Dr. Buckley observed that in the successive ice and marsh folds the anticlines are elevated much more than the synclines are depressed. This upon theoretical grounds I have held to be a general truth for the anticlines and synclines of mountain masses.[4]

Another very interesting thing in reference to the formation of the ice and swamp folds is that where two sets form they are at right angles to each other. (See p. 146.) This same phenomenon is very characteristic of crustal folds, and the explana-

[1] Principles of North American Pre-Cambrian Geology, by C. R. Van Hise; 16th Ann. Rep., U. S. Geol. Surv., Pt. I, 1896, p. 621.

[2] Principles cit., p. 622.

[3] Principles cit., p. 622.

[4] Estimates and Causes of Crustal Shortening, by C. R. Van Hise: Journ. of Geol., Vol 6, 1898, p. 19.

by Dr. Buckley is the manner in which pools and lakes of water form on the ice along folds and fractures which occur within the ice sheet itself. In this case it is well known that the water is heavier than the ice, yet the water issues through the cracks in great pools and even in lakelets upon the ice adjacent to the ice ridges. The rise of this water is due to two causes. In the first place on each side of an anticline is a natural place for synclines to form, as result of the downward thrust of the limbs of the anticline. Thus there is a direct tendency, due to the thrust of the ice, for the ice to be jammed below the water, which therefore rises to the surface through the cracks. As fast as it rises its weight is added to that of the ice and thus there is an added tendency for the process to continue. In the second place, the weight of the piled-up mass of ice along the ice ridge is transmitted to the adjacent ice, and this combined with the normal amount of ice above the water is more than sufficient to overcome the greater weight of the water, and the water rises to the surface. So far as the rise of the water to the surface is due to this second reason, it is caused by gravity. Upon the lake it is impossible to separate these two causes. In another place I have held, following Dutton and others, that gravity is one of the main factors which have caused lava to rise to the surface and have compared the rise of the lava to that of water through ice where ice ridges form.[1] In the case of the ice the thrust is produced by another force than gravity.[2] However, in the case of the earth the thrust of the crust is ultimately produced by gravity, and therefore the dominating influence of gravity in the rise of lavas. The relative sizes of the ice ridges and the pools of water are very interesting, the latter being many times the height of the former. The relations are somewhat the same as those of the great volcanic plateau of the west to the adjacent mountain masses.

Another notable point in this connection is that where an ice ridge once forms and water exudes to the surface, this freezes; and this results in greatly thickening the mass of ice for that belt. When expansion ceases and a cold period follows, the

[1] Earth Movements, by C. R. Van Hise. Trans. Wis. Acad. Sci., Arts, and Letters, Vol. XI, 1893, pp. 493-496.

[2] Loc. cit., pp. 512-514.

A fault formed in the ice.

THE PLANKTON OF FRESH WATER LAKES.

ADDRESS OF THE RETIRING PRESIDENT, C. DWIGHT MARSH, A. M.

Professor of Biology, Ripon, Wis.

For some years I have been interested in the subject of the fauna of our fresh water lakes. This interest was first aroused in regard to the animals of the deeper parts of the lakes. The results of the explorations of the depths of the ocean were just becoming known. I had read in the older works that while the sea was densely populated along shore, and had what has become to be known as a "pelagic" fauna and flora in the open sea, remote from land, the depths were a barren region utterly devoid of both animal and vegetable life. But later it had been shown that there was, even in the greatest depths, a fauna, not very abundant to be sure, but of great interest because of the strange peculiarities of some of the forms. With others I was profoundly interested in this work, and it lead me to conjecture whether there was not a field for investigation in the deeper waters of our lakes. At that time very little had been done in the way of any systematic study of the deeper waters of the lakes. I think the only extensive work on the subject was Forel's "La faune profonde des lacs Suisses," published in 1885. Professor Forel had begun his researches on the deep water fauna of Lake Leman in 1869, and had published various notices in the intervening years. In this country, so far as I know, the first publication in regard to the deep water fauna of lakes was in the first volume of the *Transactions of the Wisconsin Academy,* in a paper by Dr. Hoy, of Racine. He detailed how he had become interested in the food of the whitefish, and had examined their stomachs, finding animals that seemed new to science. A company was made up for a dredging expedition consisting of Dr. Hoy, Dr. Lapham, Professor Stimpson,

Professor Andrews and Mr. Blatchford, and put in a day's work dredging on Lake Michigan in June, 1870. The result was the collection of a considerable number of animals. Especial importance was attached to the discovery of a *Triglopsis* and a *Mysis,* as they are marine genera, and their presence was supposed to indicate a former direct connection of Lake Michigan with the ocean.

In 1874 Professor Smith published a paper on the "Invertebrate Fauna of Lake Superior," reporting the existence of the same crustacea in Lake Superior which Dr. Hoy had found in Lake Michigan. The *Mysis* there, however, occurs in somewhat shallow water as well as in the greater depths. In both lakes it forms an important—perhaps the most important—constituent of the food of the white fish and lake trout. As I was located near a lake of considerable depth, a depth reputed to be anywhere between 400 feet and infinity, it occurred to me that I had an opportunity to carry out similar researches.

My own work on lakes, then, originated in a desire to know more about the abyssal animals. I soon found, however, that the problem was a serious and complicated one, involving a complete faunistic study of the lake. I was fortunate in finding on the bottom of Green Lake the same *Mysis,* which makes its home in Lake Michigan. These animals have not been definitely reported from any other lake in the United States, although *Mysis* is said to live in a lake in New York connected with the St. Lawrence. Here was a pretty problem in animal distribution. How did these animals make their way into Green Lake? Was it by way of the Great Lakes, or did they come at some time by a connection through the Mississippi Valley? I could not tell, and I cannot today, for it becomes a problem for the geologist rather than the zoologist. With this as a starting point I attacked the problem of lake faunæ, and the battle is still in progress with no indications of a conclusion of hostilities for many years to come.

During the decade in which I have been interested in limnology there has been a very considerable advance in our knowledge of the subject, and it will be my attempt tonight to summarize this knowledge, and make as clear a statement as I can in the

brief time at my disposal of what is now known of the fauna and flora of fresh water lakes.

Russell, in his work on North American Lakes, enumerates ten agencies which, acting separately or in combination, may produce lakes. So far as our Wisconsin lakes are concerned, the most important of these agencies is glacial action. Most of our lakes occupy the depressions caused by the unequal distribution of the glacial drift, or by interference with pre-existing drainage lines. Inasmuch as Wisconsin is not a mountainous state, it follows that these depressions are nowhere of great depth, and that we have no lakes which compare in depth with those located in mountainous regions. Most of our lakes are extremely shallow, few being more than forty or fifty feet in depth. Lake Geneva, 142 feet, and Green Lake, 237 feet, are our deepest bodies of water, while our largest lake, Lake Winnebago, probably does not exceed twenty-five feet. All lakes are temporary features of the topography. The outflowing water is all the time deepening the outlet and increasing the amount of drainage, while the inflowing water is bringing in material which gradually fills up the lake bed. This process goes on with comparative rapidity, and even in our new lake areas there are numerous examples of dead lakes, where swamp vegetation entirely covers what was formerly an open sheet of water. The physical processes involved in the lives of lakes and the relation of the lake vegetation to these processes are very interesting, but this is not the time or place to discuss them, and they can only be referred to in passing.

The subject of the fauna of fresh water lakes has not been especially attractive to zoologists. This is but natural when we consider the great wealth of life in the ocean, and the comparative poverty of fresh water. Of the more important divisions of the animal kingdom the echinoderms and tunicates are entirely absent in fresh water, and the cœlenterates and molluscoidea are represented by few forms. Even the crustacea, which form the greater part of the plankton, and are present in such enormous numbers, have very few forms compared with the crustacea of the sea. It is to be expected that zoologists will be attracted by this wealth of material in the sea, and that most of them will in the future as in the past resort to the sea for their

study. It was in the ocean that the ancestors of our fresh water animals dwelt, and it is amongst those animals that the student may expect to find the most information in regard to the development of life on the earth.

But the lakes have their fauna, a fauna of great numbers if not of great variety, and because of their isolation and somewhat peculiar conditions, present a very interesting study in the distribution of animals. Of course the best known members of this fauna are the fishes, whose numbers, habits, and food are fairly well known. Fish are so important for human food that a study of their habits comes to be a matter of commercial importance, and our federal and state governments expend large sums of money for this investigation and for the practical work of rearing and distributing spawn and young fish. In Wisconsin, too, as well as in some of the other northern states, it is a matter of great practical importance to maintain the numbers of game fish in our lakes simply for the purposes of sport. Until one has made the rounds of the summer resort lakes he has little idea of the multitudes of people who come to our state in the summer season, attracted largely by the opportunities for fishing. Hundreds of thousands of dollars are brought to us every summer in this way, and it is a good business policy which leads us to do all in our power, and even spend large sums of money, if necessary, to maintain our stocks of game fish.

It has long been known, of course, that fish are dependent for their food upon smaller animals, and it has also been known that a knowledge of these same small animals was necessary to any accurate and complete knowledge of fish, but this study was so difficult and involved so much drudgery that for a long time it was neglected.

Anything like an exact knowledge of the crustacea may be said to date back only half a century to the writings of Fischer and Claus, although some papers upon this subject had been published previously.

In 1817 Say published a somewhat extended article on the crustacea of the United States, in which he speaks of one *Ostracod*, two *Daphnias* and one *Cyclops*, as inhabiting the waters of the southern states. In 1843, in the "Natural History

of New York," was published an article by DeKay on the crustacea, which was beautifully illustrated, but added little to our knowledge of the fresh water crustacea. In fact, though *Cyclops* and *Daphnia* are mentioned, they are spoken of as "extra-limital," in spite of the fact that not a lake in New York would have failed to furnish him countless numbers of these genera, had he looked for them. To Professor Forbes, of the University of Illinois, is due the credit of making the first extensive collections of these animals in this country, and publishing accurate descriptions of them. His first paper was published in 1876, and was followed by a series of very valuable investigations, culminating within the last few years in the establishment of a floating laboratory on the Illinois River for the continued study of the fauna and flora of that river and the shallow lakes adjoining.

In Europe large numbers of investigators within the last few years have devoted themselves to the study of fresh water animals and plants. Preëminent among them have been Forel and his co-laborers on Lake Leman, and Zacharias and his fellow-workers in the station at Lake Plön in Holstein. This station at Plön was, I believe, the first permanent fresh water station in the world. Since its establishment in 1891, a considerable number of permanent stations have been established in various parts of the world. It is not my purpose here to give a history of these establishments, for that has already been exceedingly well done by Professor Ward. I may call attention in passing, however, to the fact that the work in this country has been done almost exclusively in our immediate vicinity, Illinois, Wisconsin, and Michigan having published by far the most material on this subject. Similar work has been prosecuted in Minnesota, Ohio, and Indiana, but very little has been done in the other states, if we except the exceedingly valuable work of Whipple.

In Wisconsin, work has been prosecuted on the Madison lakes and Green Lake for many years, and now, under the auspices of the Natural History Survey, a more extensive and systematic biological survey of the lakes is being made, probably a more extensive comparative study than has been attempted elsewhere. While this study is of especial scientific interest, as has been in-

timated before, it is of great practical interest in connection with the problems of fish culture. It may not be likely that, as suggested by a recent writer in *Forest and Stream*, the future angler will carry with him a thermometer and chart with a statement of the laws of vertical and horizontal distribution, but such study does give a fundamental knowledge which is of vast importance to the angler as well as to the fish culturist.

The terminology used in the study of the fauna and flora of fresh-water lakes, as in the sea, was formulated by Häckel. Under the term "plankton" is included all living things, animal or vegetable, found in the water which do not move from place to place by their own volition. Fishes are not considered a part of the plankton. The life of the sea may be considered as "littoral," "pelagic," and "abyssal." To these terms Häckel adds "zonary", to include those animals which are supposed to occur at zones of different depths in the ocean. In the littoral and pelagic planktons we may have both animals and plants, but in the abyssal no plants are found except bacteria. The study of the pelagic and abyssal faunas has been entirely within the last half century; in fact the very knowledge of their existence dates back hardly fifty years.

In the lakes we use a similar set of terms. The regions are "littoral," "limnetic," and "abyssal." The characteristics of these regions are somewhat known, but still our knowledge is far from perfect.

A list of the plants and animals found in any one lake seems quite formidable because of its length, but the species that are present in any considerable numbers are very few. From a limnetic collection, for instance, we may find in abundance the following: four or five copepods, five or six cladocera, three or four protozoa, and perhaps two rotifers. This would be a fair average fauna in one of our lakes. Of the plants, we would find two or three diatoms and as many algæ.

Not only are the animals and plants of neighboring lakes very much alike, but the same animals may be found distributed over wide territories, and even over different continents. This is true even of some of the higher animals of the plankton, like the crustacea. Of our fifteen species of *Cyclops* nine are found

in Europe. In the case of one species it is not only found in Europe, but in Asia and in Africa, and literally does not vary a hair in these widely separated localities. On the other hand, the genus *Diaptomus* is very variable. We have not a single species which is common to the European lakes. Not only that, but there are many localized species in the United States. One species occurs, so far as known, only in a few lakes in the northern part of the lower peninsula of Michigan. A second is widely distributed in all the smaller lakes across the continent in the northern states. Another goes from the center of Wisconsin north into the Arctic regions. In the Rocky Mountain regions are several peculiar species. Through the southern states two species are found which never come north. Mexico has at least one peculiar species. Of the other organisms, both animal and plant, most are world-wide in their distribution. From this fact of the general uniformity of fauna and flora over wide regions, it is clear that the study of a lake which simply produces a faunal and floral list is of very little value. There was a time when such lists were important, before this uniformity of distribution was determined, but that time is long since past, and those European authors who continue to fill the proceedings of learned societies with lists resulting from desultory explorations of one or more lakes are almost wasting printers' ink.

In the littoral region we find usually an abundant flora. Those plants which need an anchorage find it in the mud of the bottom, and the unattached plants are protected by those that are stationary. Protected by these plants and living upon them is an abundant fauna in which crustacea are the most prominent, although we find great numbers of rhizopods, infusoria, sponges, hydrozoa, worms, true insects and mites, mollusca and bryozoa. This abundance of the lower animals forms a rich supply of food upon which the higher animals can live. It is in this littoral region that the fish get the most of their food, and every fisherman knows that marshy borders are necessary to maintain the supply of fish. The animals of the littoral plankton are opaque, and generally are so colored that when they are at rest they are inconspicuous. Those that swim about and then drop to the bot-

tom to rest are ordinarily so colored that they are not easily distinguished from the mud. Frequently in littoral regions the bottom is covered with a thick mat of *Chara*, which, in turn, forms hiding places for enormous numbers of the invertebrates.

The flora of the limnetic region can be, of course, only of floating plants. Among these are an enormous number of diatoms. *Chlorophyceae* are present in larger or smaller numbers and sometimes large numbers of the *Cyanophyceae*. Generally speaking, the limnetic flora is not sufficiently abundant to attract attention, but on some lakes they are sometimes multiplied in such quantity as not only to attract attention but even to excite alarm. The surface of the lake has a thick coat of bright green, and as this is cast up on the shore by the waves it forms ridges which in their decay become very offensive. This phenomenon has been known in England as "the breaking of the meres," in Germany as the "Wasserblüthe," and in this country as the "working of the lakes." The appearance is sometimes ascribed to the seeds of littoral plants. Only a few species of plants are concerned in this phenomenon, and the species differ somewhat in different lakes. Certain diatoms may be present, too, in sufficient numbers to produce an unpleasant "fishy" smell in the water. This exaggerated growth of the limnetic flora is most pronounced in shallow or comparatively shallow lakes, and is frequently a source of great annoyance to cities which get their water supplies from such bodies.

The limnetic fauna, as I have said before in this address, has but few kinds of animals, by far the most numerous and characteristic being the crustacea. These are beautiful, transparent, and nearly colorless creatures. It is not true, as is sometimes stated, that the limnetic fauna is entirely distinct from the littoral. The general character of the limnetic animals is certainly different, and distinctly different, from that of those found in the littoral region, but many individuals are common to both. It is true, however, that while there is hardly a radical distinction between the two faunæ, certain species are common to the limnetic regions and only rarely found in the littoral, while some that are everywhere in littoral collections are rarely found in those taken in the open water. There is, of course, no

clear dividing line between the two regions, but one insensibly merges into the other, while, under the influence of the winds and waves, such limits as exist are continually changing.

In the species of crustacea there is a certain distinction between the limnetic fauna of the deeper lakes and that of the shallower. One species of *Diaptomus* is found everywhere in the Great Lakes, but in only three of the Wisconsin lakes—Lake Geneva, Green Lake, and Cedar Lake. The shallowest of these lakes—Cedar Lake—is about a hundred feet in depth. One of the species of *Cyclops* is very abundant in the Great Lakes, but is seldom found elsewhere except in comparatively deep lakes.

In a paper published in the Transactions of the Academy, I made the suggestion that lakes might be divided according to their faunæ into the deep water and the shallow water, suggesting as a possible limit between the two 40 meters. I have since found that Elkhart Lake, 117 feet, and Cedar Lake, 95 feet, have many characteristics of the deep water fauna, and it is possible that the dividing line should be nearer 30 meters than 40.

The German authors make a distinction between "plankton-poor" and "plankton-rich" lakes, which very nearly corresponds to my deep-water and shallow-water lakes; for the total amount of plankton in the deep lakes is very much less than in the shallow lakes. This is easily explained. For the number of animals is, of course, dependent on the number of plants. Inasmuch as plants are dependent upon sunshine, they will grow in water only in those places that are reached by the sun's light. As the light of the sun penetrates in deep water only to a limited distance, the deeper parts of our lakes are entirely devoid of plant life. On the other hand in shallow lakes not only do we find the floating vegetation as in the deep lakes, but as the light reaches the bottom over a larger proportion of its surface, we have in addition a very large flora flourishing on the bottom. In some of the very shallow lakes nearly the whole bottom is covered with a rank vegetation. This is true, for instance, of Lake Vieux Desert. In Green Lake, on the other hand, inasmuch as the shores are somewhat precipitous, there is only a comparatively narrow margin on which can be supported a flora

growing upon the bottom, while the larger part of the lake is so deep that only the floating vegetation can exist. It is easily seen, then, that a shallow lake will be "plankton-rich" as compared with a deep lake. Fishermen recognize this fact, and expect the shallow lakes to be better for their sport.

It is evident, then, that the living limnetic vegetation must be at or near the surface, where it can have an abundance of light. Animal life, however, is not limited in this way. It was long ago shown that in the sea there was an abundant surface fauna and an abyssal fauna, but in regard to the condition of the intermediate region there has been some dispute. Agassiz has claimed that there is a region intermediate between the top and bottom, which is entirely devoid of life. This has been disputed by some authors, and late explorations seem to indicate that no region between the surface and bottom is entirely free from animals. A similar condition exists in the lakes. By far the most abundant fauna is at and near the surface, but animals are found in greater or less numbers at all depths. The larger part of the plankton is found within thirty or forty feet of the surface; but the same kinds of animals that form the fauna of the upper waters may be found at all depths, although in small numbers. *Limnocalanus* is an example of an animal which belongs to the intermediate regions. It, too, may be found in small numbers at any depth from the surface down, but it seldom occurs in any considerable numbers outside the intermediate region.

Limnocalanus and *Daphnia pulicaria* are perhaps the only animals in fresh water which belong distinctly to the zonary plankton, although *Cyclops brevispinosus* is much more abundant between five and twenty meters than it is near the surface.

Collectors of plankton material have known that they could ordinarily make much more abundant collections at night than in the daytime. This has led to a belief that there is a vertical migration of the plankton, towards the surface at night, and away from it in the daytime. It was supposed that the whole body of the plankton moved up and down. This idea has been proved to be false. What movement there is is within quite narrow limits near the surface, and all members of the limnetic

fauna do not, by any means, behave in the same way. They have most decided individual peculiarities, so that we cannot speak of the movements of the fauna as a whole, but each species must be considered by itself. Some of them do not move at all vertically, but have the same distribution from one end of the day to the other. Others, like the larval forms of the copepods, are more numerous at the surface in the daytime than in the night. Some have a very pronounced migration. This is particularly true of *Leptodora* which is rarely found at the surface in the daytime, but appears at almost exactly forty-five minutes after sunset, remains at the surface during the night, and disappears again at just three-quarters of an hour before sunrise.

Most of the larger crustacea which form the great body of the plankton do migrate in this way, and it was natural, perhaps, to infer that the whole plankton moved up and down.

The limits of this vertical migration it is very difficult if not impossible to fix. Most of the movement is within one meter of the surface, the most marked changes being within one-half meter of the surface, and below three meters the amount of movement is very slight. Eight determining factors have been listed by Professor Birge as controlling the vertical distribution of crustacea: food, temperature, condition of the water in respect to dissolved oxygen and other substances, light, wind, gravity, age and specific peculiarities. Of these factors, by far the most important are food, temperature and light. Inasmuch as the food supply is controlled by temperature and light, we may speak of these two factors as, in the main, controlling the vertical distribution of the limnetic plankton. Of these two factors, temperature is the most important, although light has a marked effect on many species. In the winter season when the waters of all the lakes are very nearly uniform in their temperature from top to bottom, the vertical distribution of the limnetic fauna is much more uniform than in summer.

In the summer season the most marked changes in vertical distribution are correlated with the vertical changes in temperature. This is most distinctly seen in the deeper lakes. In these lakes it is a surface layer of greater or less depth which is warmed, the deeper layers feeling the effect of the summer's

sun only very slightly. In Green Lake below 40 or 45 meters the temperature never rises above 6.11 degrees Centigrade, although the surface may run as high as 26.67 degrees C. In Lake Michigan the bottom temperature at depths of 360 feet is 4.2 degrees C., with a surface temperature of 18.3 C.

The change in the temperature from the top to the bottom is not a gradually decreasing one, however. A layer of water at the surface, which may be in midsummer some ten or twelve meters in depth, is very nearly uniform in temperature. From the lower surface of this layer there is a very rapid decrease in temperature for a short distance, and then a gradual decrease until a minimum is reached. This layer of sudden change in temperature is known as the "thermocline," and its position varies in depth with the season and the size of the lake. As the summer season progresses the thermocline grows lower. In the very shallow lakes the temperature during the summer season is nearly uniform through the whole depth. In Lake Winnebago, for example, there is seldom a difference between top and bottom temperatures greater than two degrees. In small lakes the thermocline is considerably higher than in large lakes. This is doubtless due to the influence of the winds, by which the small lake is less affected. This was very prettily illustrated in a comparison of the Waupaca lakes with Cedar Lake and Green Lake about August 1st of this last summer. In three of the Waupaca lakes—Rainbow, McCrossen and Beasley's, of which Rainbow is the largest and Beasley's the smallest, the thermocline was respectively at six meters, five meters and three meters. At the same time the thermocline of Cedar Lake was at eight meters, and the thermocline of Green Lake at eleven meters.

The vertical distribution of the plankton has a very close relation to the thermocline, most of the animals being above it. *Limnocalanus, Daphnia longiremis* and *Daphnia pulicaria,* however, are found below the thermocline, and in some plankton-poor lakes the proportion of the other organisms below the thermocline is much larger.

It is evident that the circulation of the water is in the layer above the thermocline, and that below the thermocline there is insufficient oxygenation, and that this bottom layer must, too,

hold a great deal of the dead and decaying material falling from the upper layers. It is a curious fact, first pointed out, I think, by Whipple, that the bottom waters of deep lakes are stagnant during both winter and summer, but have a period of overturning in spring and fall. This overturning may come with considerable suddenness when the waters have not been much agitated by the winds. We ordinarily think that water is so mobile that the heavier portions will immediately sink, and thus the water of greater density will always be at the bottom. It may happen, however, as in the fall, that the upper waters will cool off, and yet retain their position, so that the lighter water will actually be below. The lake is in a condition of unstable equilibrium. If, under these circumstances, there comes a heavy wind, the whole body of water will overturn.

It is at these two periods of overturning, as shown by Whipple, that the growth of diatoms is especially pronounced, and they are found present in enormous numbers in the limnetic plankton. The great growth of diatoms is explained in the following way: during the periods of stagnation diatoms or their spores, if diatom spores exist, accumulate at the bottom of the lake, inasmuch as their specific gravity is greater than that of water. They do not grow there, because sunlight is essential to their growth. At the bottom is accumulating during this period, too, a large amount of organic matter from the decay of organisms near the surface, and this, under the influence of bacteria, is transformed into material fitted for food for the diatoms: in this food material the nitrates are perhaps the most important. When the time of overturning comes, the diatoms or their spores rise to the surface, accompanied by these dissolved organic materials, and, under the influence of sunlight, an exceedingly rapid multiplication takes place. As the food materials are used up the numbers of diatoms decrease again. Other organisms, of course, show the effect of the overturning of the water, for many are directly or indirectly dependent upon the diatoms for food, and, besides, diatoms are not the only organisms which can make use of the food materials which are thus brought to the surface. *Diaptomus*, *Epischura*, *Limnocalanus* and two species of *Cyclops* show quite clearly these two periods of rapid

production, although in some of these cases the results are complicated by the fact that the temperature of the surface water has a direct effect on the reproduction.

The matter of the annual distribution of the organisms of the plankton is a very interesting question, but is also a very complicated one. As has just been stated, certain of the diatoms have a distinct spring and fall maximum, and there are other organisms which, because of their dependence upon the diatoms, have similar periods of maximum growth. But there are other causes at work which control the growth of individual organisms, so that their optimum periods may come at very different times of the year.

Generally speaking it is probably true that the largest amount of plankton occurs in midsummer, although Yung says that the maximum development of plankton in Lake Leman is in May or June, and that the minimum is in March and September. Zacharias states that the maximum period for Lake Plön is about August 1st. Measurements of a large number of collections from various lakes in Wisconsin indicate that the maximum of plankton occurs in these lakes in the latter part of July. There may, however, be marked exceptions to this general statement. For example, I have found in Green Lake a development of diatoms in midwinter so enormous as to make the total plankton even greater than in summer. The exact period of maximum development may vary from year to year, and in different lakes, because of varying local conditions. The reason for this July maximum seems to be both because a considerable number of organisms have their highest development, and because there is a greater variety of forms at this time than at any other time of the year. This is undoubtedly because of the peculiarly favoring conditions of temperature. It is this time of the year that seems to be especially favorable to the growth of the algæ. The "water-bloom" may appear in June and remains sometimes until into September, but it is in July and August that it is present in the greatest quantity. This summer, on Lake Winnebago, it was most abundant during the latter half of August.

The minimum of plankton development is in the winter months, especially in January and February. At no time of

the year, however, are either plant or animal forms wanting, and collections made through the ice will give a considerable variety of kinds, as well as numbers of individuals.

It will be noticed that the period of maximum plankton development corresponds to the time of highest temperature of the water, and that the period of minimum development corresponds to the time of lowest temperature, so that we can be certain that the one important controlling factor in the growth of plankton is the temperature.

Henisen and his co-laborers who worked out a very elaborate system of measuring the plankton of the sea claimed that the distribution of the plankton over wide stretches of the sea was nearly uniform. Granting this to be true, it evidently is possible by a series of collections and measurements to compare different parts of the ocean in regard to their productiveness in animal and plant life. This conclusion, that the horizontal plankton of the sea has a practically uniform distribution, has been accepted by the majority of scientists, although vigorously combated by Häckel.

Apstein has applied the same methods to the examination of lakes, and has concluded from his investigations that the plankton of lakes is uniformly distributed. It is easily seen that there is very good reason for assuming this to be the case from the actual conditions under which the plankton exists. The plankton consists of organisms that do not move voluntarily from place to place, and therefore do not change their positions. They are dependent upon heat and light for their development, so that their growth is mainly within forty feet of the surface; consequently a depth exceeding this would not mean any greater production of plankton—or in other words, the amount of plankton depends not upon depth, but upon surface.

This is a most important conclusion, if true, for it gives us an exact method by which we can compare one lake with another and determine their relative productiveness, or from a series of collections, determine the absolute annual productiveness of any body of water. Such determinations would have an important commercial value, for by them could be estimated the possibilities of fish production in a lake. The method was worked out

in detail and very elaborately by Hensen. The collection was made by a conical net of bolting silk drawn vertically through the water, thus straining out the organisms of a column of water of the size of the opening of the net. Then the material was counted under the compound microscope by a very laborious process. In this way exact numerical values can be obtained not only for the plankton as a whole, but for the individual constituents. Most investigators use Hensen's methods with greater or less modifications, and they have been productive of very fruitful results. But, unfortunately—I say unfortunately, because we all like to claim exact results, and are prone to think that nature works according to certain inflexible laws—much of the laborious detail of the work is a waste of time.

The question of the uniformity of horizontal distribution has been discussed by various authors and with considerable vigor, but I think it must now be acknowledged, that while there is a certain amount of uniformity, so that, by a considerable number of collections, we can express within rather wide limits the amount of plankton at any time on a lake, uniformity in any exact sense does not exist. This lack of uniformity is largely due to a difference in the number of crustacea, although there are marked differences in the distribution of the other organisms. Surface growing plants, for instance, are moved about under the influence of the winds, and accumulate on the leeward side of a lake. If one part of a lake is deeper than another and the lake is not much disturbed by the winds, at the period of maximum growth the number of diatoms will be much greater over the deeper part. Crustacea may be in ill-defined aggregations which may be called swarms, and these swarms are not stationary in all cases, but move slowly, perhaps under the influence of extremely weak currents. Not only is there a considerable variation in collections made at different locations on a lake at the same time, but if a series of collections is made at the same place, the amount of the plankton in some collections may be twice as much as in others. An examination will show that these large variations are generally due to a difference in the numbers of some of the crustacea, showing conclusively that not only do the numbers of crustacea vary at different locations,

but that these swarms are not stationary. It follows, then, that conclusions in regard to the plankton drawn from a few collections may be quite erroneous. If, however, a considerable number of collections is made, especially if they are made from widely-separated localities, the average of all these collections, allowing something of a margin for error, will give a fair idea of the amount of plankton in a lake. Of course, the larger the number of collections the less the amount of error, but anything like very exact results cannot be expected. We are able, in this way, to compare the plankton of one lake with that of another, or to determine the relative amount of plankton at different times of the year on any single lake. But any estimate of the actual amount of plankton produced by a lake at any time or during the year must be acknowledged to be only an approximation. Care must be taken, too, in comparing one lake with another, that they be compared under similar conditions. The maximum of one lake may not be reached at the same period as that of another. The conditions of a deep lake are very different from those of a shallow lake, and a fair comparison can be made only by averaging collections continuing over a considerable period.

In the abyssal region, because of the lack of light, plant life is impossible, and the fauna is very meager.

It is true that the list of animals which have been found in the abyssal regions of lakes is a long one, including, as it does, protozoa, cœlenterata, worms, molluscs, bryozoa, crustacea, arachnida, insect larvæ, and some few fish, but an examination of any single lake shows that not only is the number of kinds small, but the numbers of individuals of any kind are very small. In Europe the abyssal fauna of Lake Leman has been worked up with great thoroughness. In this country very little detailed work has been done on this subject. It is not a fruitful field for research, and it is not strange that it has been neglected. In shallow lakes it is doubtful if there is any distinctive abyssal fauna. The most abundant animals in the mud of the bottom are worms, insect larvæ, gasteropod and lamellibranch molluscs, and amphipods. With these may be associated at times great numbers of other animals, as occasionally one finds in the mud of shallow lakes large numbers of fresh-water hydra. Most if

not all of these animals are identical with the littoral forms, and the difference between the littoral fauna and the deep-water fauna is that in the deep water those forms which are especially dependent upon the weeds for food and protection are lacking, while we find in abundance the mud dwellers.

In the abyssal regions of deep lakes, however, we find forms which are characteristic of those regions, although they may be mingled with others that are also found in the littoral region. In the abyssal region of Green Lake, which may be considered the typical deep-water lake of Wisconsin, are found, besides some undetermined worms, a little lamellibranch, *Pisidium*, ostracods, amphipods, insect larvæ and *Mysis*. There are some protozoa in the mud, but they have not been studied. The ostracods are so numerous that their shells form a conspicuous part of the bottom deposit.

In the smaller lakes of a depth ranging from 60 to 100 feet, like the Waupaca lakes and Elkhart, a different condition of things exists. The bottom is composed of a dark mud, and is almost completely devoid of life. This has been a puzzling fact, and has been to me personally a matter of considerable disappointment because of my interest in abyssal animals. The probable explanation seems to be that these depths are rendered unfit for life by reason of the more complete stagnation of the deep water in small lakes, and because of the larger amount of organic matter which is being decomposed there. Because of the small areas of such lakes, leaves are carried from the shore all over their surfaces, and, sinking to the bottom, increase largely the amount of decaying organic matter. Partly decomposed leaves are common in the bottom collections of small lakes but rare in lakes of the size of Green Lake or Lake Geneva. This may account largely for the black color of the bottom mud. Then, in a large lake, the winds indirectly produce slow bottom currents. A prevailing wind will pile up the water at the end of a lake; this water must return in some way, and there is good reason to think that at least a part of it returns by a slow bottom current. Professor Birge tells me that his temperature observations give evidence of such a movement of the water. It follows, probably that in the large lake there is not perfect stag-

nation, and hence the conditions of the bottom are more favorable for animals than in a small lake. The larger the lake, then, other conditions being equal, the greater would be the abundance of abyssal life. While there have been no accurate means of comparing the abyssal fauna of the Great Lakes with that of the smaller lakes as to quantity, such collections as have been made would indicate that it is much greater in the Great Lakes, and decreases in proportion to the degree of stagnation. If my explanation proves to be the correct one, as I feel quite certain it will, it will follow that the small deep lake will be limited in its fauna in two ways: because of its steep shores it will have a small littoral fauna and flora, and because of its stagnant deep water it will have little or no abyssal fauna.

I have thus far spoken as though all lakes had the three faunæ: littoral, limnetic, and abyssal. Generally speaking this is true, even small bodies of water showing this distinction. But occasionally the distinction is almost lost. This is true in Lake Winnebago. In spite of its great size—the lake is some twenty-eight miles long by ten or twelve broad at its greatest width—it is only about twenty-five feet deep. In its fauna there is a curious mingling of littoral and limnetic forms, littoral forms being found in the open lake, and limnetic forms even among the weeds along shore. The explanation seems to be this: because of its slight depth the environment, even far from shore, is favorable to the growth of littoral forms. Then there is good reason for thinking that the winds have a profound effect on its waters, thus thoroughly mixing limnetic and littoral waters, and consequently causing a similar mingling of the organisms. Lake Winnebago has the characteristics, in many respects, of an enormously overgrown puddle. I do not say this, however, to show a lack of respect for this lake, for from a practical standpoint it is a most valuable possession to the state. It can support, and does support, an enormous number of fish. Few lakes can compare with it in productiveness.

All the inhabitants of fresh water are, of course, descendants of marine forms. In some cases the modifications have been very great but in others they are hardly to be distinguished from their salt-water relatives. This is true, as has already been

stated, of some of the crustacea: in some of these it is difficult to make a specific distinction between the fresh-water and marine forms. Most of the environmental conditions in fresh water are so different, however, from those in the sea, that we should expect a fauna to develop itself which would differ widely from its ancestors.

It will be noticed that the most pronounced likeness to marine animals, perhaps, is found in the abyssal forms. So far as this is true, it may be explained, I think, by the uniformity of conditions existing in the depths of lakes. The temperature varies but a few degrees from one end of the year to another, and such currents as exist are slow and almost imperceptible. The abyssal fauna of a lake is subject to nearly the same conditions as that of the sea, except for the difference in the composition of the water. If, as has been supposed, the deep-water fauna of the Scandinavian lakes is descended directly from the deep-water fauna of the sea, coming from the sea into lakes having a communication with salt water, and surviving there after the lakes were cut off from the sea, and their waters had become fresh, we can see how the animals could gradually adapt themselves to their surroundings, inasmuch as the conditions of light, temperature, and food supply would remain with very little change.

With the limnetic and littoral fauna, however, a very different condition exists. In our climate the temperature of the surface varies during the year from the freezing point to eighty degrees or more Fahrenheit. In shallow lakes, not only is there this variation of the surface, but the lake may be frozen to the bottom in winter, so that all forms which can not go into a resting stage of some kind are destroyed. The conditions of life are hard, and especial fitness is required in order to make survival possible. In the sea, on the other hand, the conditions even of the littoral and pelagic fauna and flora are much more uniform. It is not strange that the fresh water animals and plants are of few kinds, and that generally they are very different from those of the sea. It is perhaps more strange that so many resemblances remain, and that the forms are so varied as they are.

To trace out the connection of the individual forms with their marine ancestors is, of course, the work of the specialist in zool-

ogy and botany. It may be noticed, however, that the present population of our lakes has come since the glacial period, in fact the lakes themselves only date from that period. So far, then, as the fauna and flora pass from one body of water directly to another, we may assume that the present animals and plants are descended from those that were pushed south by the ice, and that as the ice retreated they followed again towards the north.

Currents carry organisms from one part of a lake to another, and from one lake to another by connecting streams: in this way animals or plants introduced at the source of a river may be carried through its whole length.

From lake to lake, too, seeds, eggs, and living animals are carried by water fowl attached to their feathers or in the mud upon their feet. This is not simply from one lake to its neighbor, but many of these birds take long flights before alighting, so that the organisms are scattered over a wide stretch of territory. It is in this way, probably, that we can account for the uniformity in the fauna and flora of the lakes and the wide distribution of some of the forms. Where conditions are similar, then, we may expect likeness in the fauna and flora. As we have seen already, temperature is the great controlling factor in distribution, so that in lakes of the same latitude or the same elevation, other conditions being equal, of which the principal is depth, we may expect close similarity in fauna and flora.

We may assume, then, that the littoral fauna and flora have had their origin from neighboring bodies of water, and that as the ice retreated, the lakes were populated, partly by direct migration between contiguous bodies of water, and partly by the aid of the winds, currents, and water fowl. The limnetic fauna and flora is descended either from littoral forms which have gradually adapted themselves to limnetic conditions, or from pelagic forms, which, in bays where the water was less salt or brackish, have become adapted to the conditions of fresh water, and have been distributed by the same agencies as the littoral forms.

Part of the abyssal fauna is descended from marine forms directly, as in the "fauna relicta" of the Scandinavian lakes, and in the case of some of the animals in our Great Lakes. Another

part of the abyssal fauna is descended from littoral forms which have gradually moved into deep water, and have been modified to suit their new environment. All the abyssal fauna of the Swiss lakes is supposed to be of this character.

What I have said thus far applies almost exclusively to lakes of the temperate zones, for it is there that lakes exist in the greatest numbers, and it is upon such lakes that most of the work of investigation has been done. But there are lakes in warmer climates, and we may expect that a thorough study of them will give us much that is new and interesting. A striking example of the extraordinary interest that may be attached to such lakes as Lake Tanganyika in Africa. Some years ago it was reported that a jelly fish was abundant in its waters. This excited the curiosity of zoologists, for the *medusa* is a marine form, and very rarely is found in fresh water, the most noted case being of the one found in the basin in Regent's Park, which is supposed to have been brought with plants from some tropical country. The *medusa* of Tanganyika is one of four jelly fish known to live in fresh water, and the other examples are very rare. A special expedition was organized to make an exploration of Lake Tanganyika, and although this work was very imperfectly done, the results appear to be of great interest. Along with the ordinary lacustrine fresh-water fauna there is a fauna of marine origin, but this marine fauna is not closely related to modern forms. It does, apparently, closely resemble Jurassic forms. Indeed, it is said that were some of the forms referred to a paleontologist, he would not hesitate to say that they belonged to Jurassic times. Have we here, then, a "fauna relicta" which dates back to Jurassic times? It is too early to answer this question with any certainty, both because of our imperfect knowledge of the fauna of Lake Tanganyika, and because of our great ignorance of the geology of that part of Africa. But the mere possibility that this may be true is startling, and should incite scientists to a thorough study of the fauna and flora of Lake Tanganyika and the other lakes of Central Africa. So far as explorations have gone this "halolimnic" fauna as it has been named, is peculiar to Lake Tanganyika, but we may expect to find more or less of it in other lakes.

A few words in regard to the work on plankton which remains for the future investigator. It will, I think, be evident, that so far as exact and comprehensive knowledge is concerned, we have but entered a vast field. We know so little, that we can say that we are just beginning to place limits on our ignorance.

A systematic knowledge of the fauna and flora is a first and fundamental condition of comparative biological work. We need accessible manuals by which the animals and plants dealt with can be identified. Systematic work may not be the highest or the most satisfying to the investigator, but it is very necessary. The plankton student is met, at the very beginning of his work, with a difficulty that is almost a complete block to further progress; although the number of forms with which he has to deal in his plankton work may be very few, he has to have the knowledge of a specialist in each group in order to identify them. If a laboratory has a company of specialists, the material is quickly identified by passing from one to another. But if the investigator is by himself, he finds himself in a most discouraging situation. The literature of the various groups is scattered and fragmentary, and frequently is utterly useless to any one but a specialist. There is need of a manual, or rather a series of manuals, that shall so treat of the fresh water fauna and flora, that any well-trained biologist shall have no difficulty in identifying his material outside of the group which he may have made his special study.

It seems to me that we have nearly reached the time when the publication of such a manual should be possible. Most of the preliminary work has been done. More, perhaps, remains to be done on the botanical side than on the side of zoology, for the exact study of the lower aquatic flora has been much neglected. I hope that the time is not far distant when we may have such a manual produced in this country, with the coöperation of our best specialists. Nothing would do more to further the study of plankton, for it would furnish the student with a tool of inestimable value.

In regard to the plankton itself, very little is really known of the abyssal fauna and its controlling conditions. I have spoken of the fouling of the water at the periods of stagnation,

but our knowledge of the conditions of the water at those times is very imperfect. There should be a systematic examination, by chemical analysis, of the water and its contained gases, and of the mud of the bottom, and an exact comparison should be made between the lakes with sterile bottom waters and those with comparatively abundant fauna. In connection with this should be a study of the currents of the abyssal region. A more careful and thorough examination should be made of those lakes whose geological history indicates that they were formerly connected with the sea, and may contain a "fauna relicta." I may say that it is not likely that such explorations will yield any startling results. The time for that is probably past, and the lake student of the future must content himself with hard work, without the satisfaction of brilliant discoveries.

Our quantitative knowledge of plankton is only a beginning. We know something of the conditions on a few lakes, but only on a few, and we do not know what variations may be caused by the peculiarities of individual lakes. Even in the same lake the conditions may change from year to year, and in only a few instances have observations continued through a series of years. We are all prone to generalize on the facts in our hands, but it must be acknowledged that the facts upon which we can build theories of fresh-water plankton are very meager. There is need of a series of examinations of typical lakes carried on for a term of years, before we can build with certainty.

There remains the great problem, or complex of problems, of the relation of the different elements of the plankton to each other and to fish. We see, frequently, an apparent overproduction of one of the elements. In shallow lakes—at least in many of them—there is apparently a great overproduction of vegetation. How is this explained? How is the balance of life restored? What constitutes an ideal relation between the vegetable and animal growth? When we plant a new species of fish in a lake, we, of course, disturb the existing balance of organisms; may we not, in some cases, at least, work actual damage? To what extent is this balance between animals and plants maintained in a lake that is not interfered with by man?

These and similar questions, now without answers, offer a

field of almost unlimited work, and work that is worthy the best efforts of our students. For while my address, in treating of the present condition of the study of lakes, has dealt largely with isolated facts, after all it is not the facts which the student pursues as his ultimate aim, but the general laws underlying the facts. He is an unfortunate man who sees the trees, but cannot perceive the forest, who can see the stones of which the cathedral is constructed, and show how they were lifted to their places, but cannot perceive the beauty of the structure as it stands in its exquisite proportions, its massive masonry and wealth of sculptured detail only serving to express the idea of beauty and harmony in the master mind of the architect.

Ripon, Wisconsin.

AN ECONOMIC AND SOCIAL STUDY OF THE LEAD REGION IN IOWA, ILLINOIS, AND WISCONSIN.

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ALLARD J. SMITH, B. L.

INTRODUCTION.

In the summer of 1898 the Wisconsin Historical Society held a meeting on one of the days during which was celebrated the semi-centennial of the state, and at this meeting several papers were read, representing in a certain local fashion the different sections of our state. It was my good fortune to be assigned to the section of the south-west, and the new material discovered during the preparatory investigation was sufficiently valuable to arouse curiosity and stimulate further and more exhaustive treatment. Some of the results of this study of local conditions in the lead region of the states of Iowa, Illinois and Wisconsin are herewith presented. The region chosen is one peculiarly fitted for study of this kind. Several important social and economic transformations have taken place during its history, transformations that overlaid rather than obliterated the older conditions of population, industry and wealth, so that each epoch can be studied just as certainly as can the geological periods for the same area.

The ultimate purpose of this species of investigation is first to arrive at a completer knowledge of the history of the towns and counties in the state than is now possible from the perusal of the trash that has been printed under the title of county histories. Secondly, the aim is to examine the available census

reports and other public documents in order to obtain correct and adequate statistical information as to the development of the given area under study. These figures should show not only the numbers but the wealth, occupation and nativity of the population. Besides this, there should be some accurate showing of the direction and intensity of the whole industrial development of the section. This should also be accompanied by a careful geological and topographical study of the given area, as well as an account of its natural resources. Thirdly, it is desired by this study to so relate the political with the social and economic life that they shall mutually explain and account for each other. The statement of the problems of these two phases of life will thus reciprocally assist in their joint solution, where it is not possible to otherwise reach a satisfactory solution. Such is the aim of the investigation, the first fruits of which appear in the following pages. The plan can hardly be said to lack comprehensiveness, and it certainly entails an amount of careful and laborious collection and arrangement of material that can be appreciated only by those who have attempted similar pieces of work. Moreover, so extensive a study necessitates the co-operative labor of a large number of students for a considerable length of time. But this is a positive advantage, since it more widely diffuses the true historical spirit and makes its methods better understood among those who are capable of doing good work under the stimulus of the example and direction of those who have done most in these lines. There is also an added advantage in the organic nature of the work proposed; it is evolutionary in the best sense. There are no theories of state sovereignty or constitutional rights of man or nations to exploit or defend. No favoritism for section, or belief in national destiny or the over-mastering importance of a few great men is here allowed to warp the judgment or anticipate the conclusion. There is first the laying of a simple statistical foundation for later work. This is followed by carefully drawn conclusions, based wholly on the mass of accumulated evidence, conclusions drawn from many different sources and mutually checking each other so that all merely local elements are eliminated and the general truths emerge. To thus follow the development of a section into all the ramifications of its many local phases, never

losing hold of the important elements in the social, economic and political life, is a task requiring quite a different calibre of mind from that necessary to produce the average county history in any of our states.

It is not too much to say that it is time to stop writing American history in the large until we have more of it in the little. We show our national fault very conspicuously by our haste to erect stately works on foundations too often shaky and unsafe. It is fatally easy to generalize, especially for a popular and successful lecturer who has been accustomed to play the dictator to a small coterie of devoted followers. Such a habit of facile generalization may result in the production of popular histories, but it has never yet given birth to authoritative ones. Be that as it may, local history as a preparation for general history is coming into favor again. The economists, and especially the newer sociologists, are demanding more facts, at no matter what cost. They have found out the defect in our present historical methods. They know from bitter experience how unsatisfactory, superficial, and inaccurate is much of our American history. It is for us historians to face this serious condition of things and bestir ourselves to retrieve what we are daily losing. The method here outlined is only one of many that will ultimately be worked out, but they all are fundamentally alike in the emphasis laid upon the value of local material, records of the family, of the town, the parish or county. Until there is some systematic, methodical attempt made at unearthing this undiscovered wealth, it will be in vain to expect accurate or scientific histories of our nation or of any part of it. If we historians ever succeed in demonstrating to our friends in political science, economics and sociology that we represent a distinct science, it will be only after we have shown our willingness to make intelligent use of that almost unworked stratum of the historical field which is usually termed local records.

The successive chapters that follow are mainly the results of seminary work during the year 1898–9. The students, under whose names most of this material is published, did the work under my direction as senior theses.

O. G. Libby.

University of Wisconsin, September 13, 1900.

CHAPTER I.

THE LEAD REGION OF GRANT, IOWA, AND LAFAYETTE COUNTIES IN WISCONSIN.

BY O. G. LIBBY, PH. D.

Two capital events bridge the gap between the primitive history of the lead region in Wisconsin and that of the present time. These are the discovery of lead in the first quarter of the century and the Black Hawk War of 1831. The opening of productive lead fields in this section caused such a deflection of population into that quarter of the north-west that its future was assured. The military operations of the Black Hawk War, besides removing the barrier of the hostile tribes, did the same service for this region that General Sullivan's march in 1779 against the Indians of western New York did for the new lands of that section. The consequence was that by the time the battle of Bad Ax had put an end to the brief war, the rich lands of this area were quite as well known as its lead mines, and its industrial development moved forward without further interruption.

In its early years the life of the lead region of Wisconsin was closely linked with that of the South, from the fact that the Mississippi River was its one highway leading to the outside world. Southern newspapers were quoted by the local press, slavery was a state institution of early times, the whole social and intellectual tone of the section received an unmistakable Southern tinge. But this was soon changed, for the long and dangerous Mississippi route did not harmonize with the vigorous growth of the section.

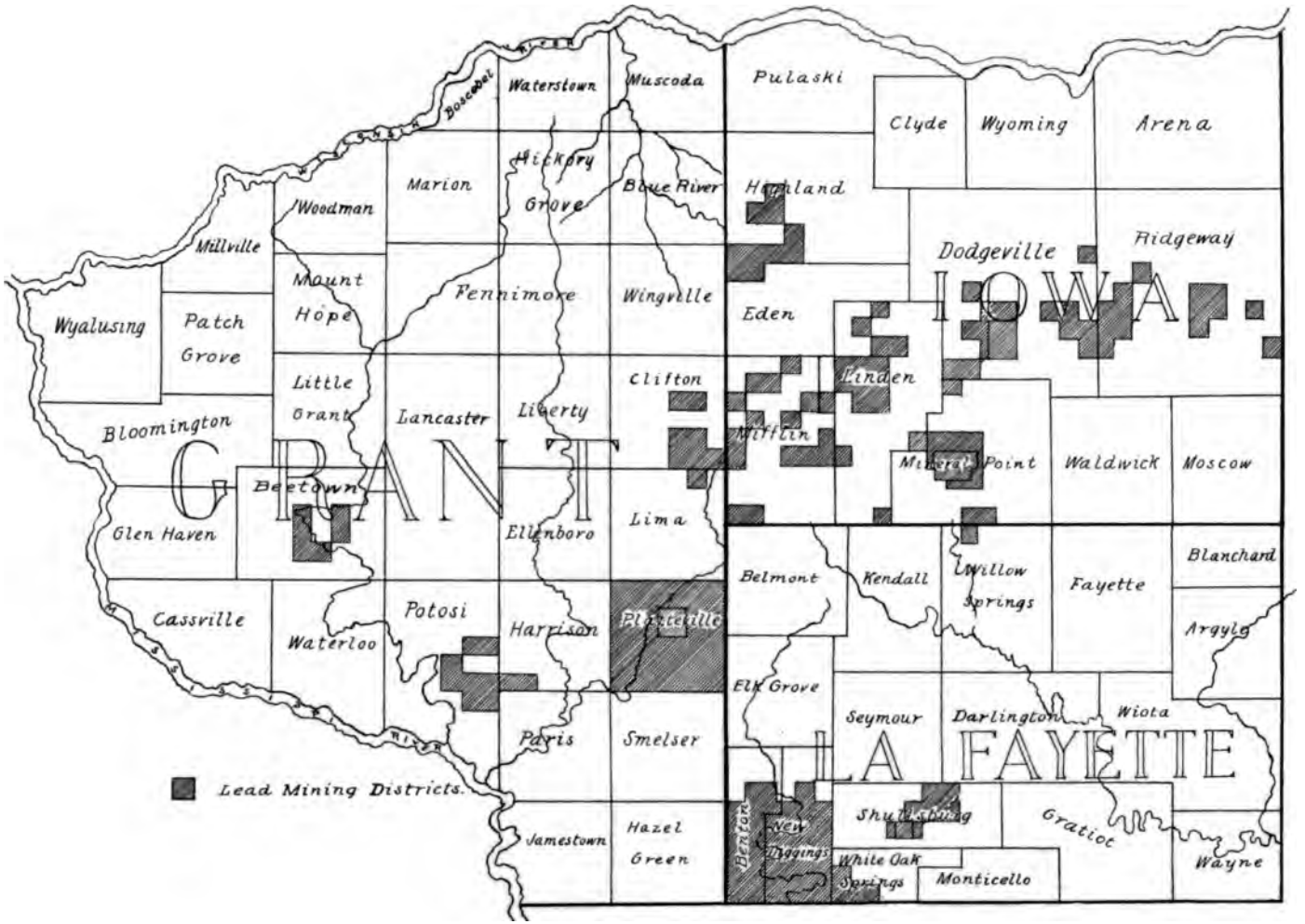
As early as 1836 the most valuable of its products, lead, began to find its way across the state to Milwaukee and other lake ports, seeking an outlet to the New York markets by this shorter overland route. The rapidly increasing agricultural products followed, broadening and deepening this pioneer path to the east. Says a writer in the Wisconsin Herald in 1848:

"It is evident our state has reached a crisis. We need annexation to the lakes; some access to the markets of the great world. When and through what avenue is light from Lake Michigan to break in upon us?"[1] The response to this demand was the magnificent net work of railroads, centering at Chicago and ramifying through the whole Northwest. The lead and shot trade tapped that great stream of emigration that was flowing westward by the Erie Canal through Michigan. This section was thus enabled to profit by the great influx of New England and New York settlers to people its untilled lands. Thus in Wisconsin the two almost antagonistic sections, the Mississippi and the Lake sections were completely united by 1850. The later union of the western section with the east by means of railroads, ushers in the last step in the development of the state.

We may now pass to the discussion of the lead-producing and non-lead-producing groups of towns in the counties of Grant, Iowa, and Lafayette. In the accompanying map those portions of the towns that are shaded show the location of sections in which lead mining was an important industry by 1840. These towns are considered as belonging to the Lead Group or Group I, and are as follows. For Grant County: Beetown, Clifton, Platteville and Potosi; for Iowa County: Dodgeville, Highland, Linden, Mifflin, Mineral Point and Ridgeway; for Lafayette County: Benton, New Diggings, Shullsburg and White Oak Springs. All the remaining towns in the three counties, those having no shaded sections, belong to the Non-Lead Group or Group II. In many of these towns there were lead mines but the area of the lead producing sections was much smaller in proportion to the total area of the town than in the case of the towns in Group I.

Taking up the subject of population first it will be seen from the table below that Group I has a population per square mile which, though showing considerable variation, tends to steadily decrease. On the other hand, for Group II just the opposite is true. Thus while the first group attains a maximum density of population of 41.9 per square mile in 1870 and declines thereafter until 1890, the second group reaches a maximum of 30.4

[1] J. T. M. in Wisconsin Herald, June 10, 1843. [Wis. Hist. Coll., XIII., 327.]


Waterstown
Muscoda
Pulaski
Clyde
Wyoming
Arena
Boscobel
Marion
Hickory Grove
Blue River
Highland
Woodman
Millville
Dodgeville
Ridgeway
Mount Hope
Pennimore
Wingville
Eden
IOWA
Wyalusing
Patch Grove
Little Grant
Clifton
Linden
Bloomington
Lancaster
Liberty
Mifflin
GRANT
Beetown
Point
Waldwick
Moscow
Glen Haven
Ellenboro
Lima
Belmont
Kendall
Willow Springs
Fayette
Blanchard
Cassville
Potosi
Harrison
Platteville
Waterloo
Argyle
Elk Grove
Seymour
Darlington
Wiota
Paris
Smelser
LA FAYETTE
Lead Mining Districts.
Jamestown
Hazel Green
Benton
Shullsburg
Gratiot
White Oak Springs
Monticello
Wayne

only in 1895. On the other hand, Group I has a considerably greater density of population per square mile than has Group II. This latter fact finds some explanation in the difference be-

TABLE I.—*Population, 1860–95.*

	1860	1865	1870	1875	1880	1885	1890	1895
Lead area, Group I:								
Total	27,144	30,866	33,410	33,230	31,814	30,898	29,606	30,628
Per cent. of gain, +, or loss, —	.....	13.7+	8.+	.3—	4.4—	2.8—	4.—	3.4+
Per square mile ...	34.8	38.7	41.9	41.6	39.9	38.7	37.1	39.7
Non-lead area, Group II:								
Total	40,001	43,757	51,668	52,108	50,934	48,718	49,427	52,679
Per cent. of gain, +, or loss, —	.....	9.3+	18.+	.8+	2.—	4.3—	1.6+	6.5+
Per square mile....	23.1	25.3	29.9	30.1	29.4	28.2	28.9	30.4

tween the two groups in soil. Group II has a large area of sand and contains a smaller per cent. of the most fertile soil than does Group I.[1] This partly accounts for the difference in density of the population but the steady decline in population noticed in Group I has no such explanation. We find, then, in this small first group conditions more favorable to agriculture that in the second group, but in spite of unfavorable soil this latter section has a population growing more rapidly than that of the older and more densely settled section. In other words the younger portion of the population has for many years been drained away from the towns of the first group, leaving the older and more conservative part to continue on in the economic and social habits that were peculiar to the people of this section in the early part of our history.

But with these differences in increase of population are associated others of a different nature. In the subjoined tables are to be noticed various differences between the two groups of towns

[1] See map of soils facing page 199.

TABLE II.—*Per capita valuations of farms and farm produce.*

	1885.		1895.	
	Group I.	Group II.	Group I.	Group II.
Farm values	357.2	445.1	343.4	517.8
Farm implements	10.2	14.0	7.1	11.3
Agricultural produce	54.8	80.4	52.8	77.4
Live stock	94.9	121.3	69.5	98.8
Dairy produce	8.7	9.4	12.5	16.0

TABLE III.—*Farm produce per capita.*

	1877	1880	1882	1886	1889	1892	1895	1897
Bushels of wheat—								
Lead area, Group I	5.6	4.8	3.4	3.1	1.9	1.7	.6	1.4
Non-lead area, Group II	7.1	9.5	5.0	4.9	3.5	3.4	1.2	2.4
Bushels of corn—								
Lead area, Group I	52.1	59.8	48.4	23.3	42.6	36.1	23.8	60.4
Non-lead area, Group II	105.0	77.6	76.1	43.6	56.1	48.3	33.7	95.2
Bushels of oats—								
Lead area, Group I	41.1	44.0	49.0	40.3	55.9	54.6	42.7	56.7
Non-lead area, Group II	68.6	58.2	64.1	60.1	92.1	55.8	46.5	84.1
Pounds of butter—								
Lead area, Group I	16.6	22.4	26.0	26.9	35.3	23.6	40.1	38.0
Non-lead area, Group II	26.1	33.1	41.1	42.8	47.8	34.1	33.9	54.5

as to their wealth-producing power. In the first table for 1885 and 1895 the per capita products of the two groups are contrasted in agricultural produce, live stock and dairy produce, as well as in per capita of farm values and farm implements. In comparing the Lead Group with the Non-lead Group as to per capita of farm values and farm implements it is seen that the former is much smaller in each case and that in farm values there is a marked decline. In agricultural produce, live stock and dairy produce the same is to be noticed. Though in the first two items there is seen to be a decline in the per capita product

of each group yet in all of them the second excels the first at every point.[1]

In the second table is seen a still more striking proof of the agricultural superiority of Group II over Group I. The per capita production of wheat, corn, oats and butter for the two groups is compared for a period from 1877 to 1897. The yield of wheat has declined in both groups, more in I than in II. Oats and butter are both products that are increasing in value during the entire period, the towns in Group II taking the lead. In the per capita of corn, Group I shows an increase in twenty years while Group II though showing a decline, still far excels the other in per capita production. Especially significant are the figures for corn and oats since the production of these cereals is connected closely with stock raising. The production of butter is also an important one in the same connection. The newer methods in farming are thus seen to make the greatest progress in the second group of towns. The conclusion which irresistibly suggests itself at this point is that this decline in industrial power is connected with the corresponding decline in population. The older and more densely settled towns of the lead region in ceasing to increase in population inevitably fell behind the newer communities whose citizens were composed of young and enterprising emigrants from other parts of the country. This transference of population from one community to another and this loss of productive power on the part of certain towns are coincident occurrences. A declining community has certain well defined characteristics apparent to even a casual observer. Not only does the wealth producing power decrease but in many cases the tax paying capacity suffers and the complaint of hard times is prevalent. This feeling of resentment toward the constituted authorities because of financial stress finds expression in political action of various kinds. The rise of the greenback party,[2] the populist party or the independent voter class may often be partly accounted for in this way. The later studies in Wisconsin will bring out more clearly than is now possible the intimate

[1] For detailed figures by towns see Appendix A, pp. 231-5. The statistics are from the State Censuses of 1885 and 1895.

[2] See in this connection my study of the Greenback Movement, 1876-84; Transactions of Wis. Acad. of Sciences, Arts, and Letters, XII., 530-43.

connection between the economic and the political life of a community. It is, however, clear from the foregoing evidence that in southwestern Wisconsin there are areas having a social and industrial life different from that in the neighboring towns. Just what those differences are, how they have come about and what their effect has been in the past are questions yet to be settled by more detailed study than is now possible. The present discussion has accomplished its purpose if it has called attention to the possibilities of such historical work in purely local fields.

CHAPTER II.

THE LEAD REGION OF GRANT AND LAFAYETTE COUNTIES.[1]

F. BELLE STANTON, B. L.

The entire lead mining region comprises a much larger area than the subject of this paper. The region as a whole embraces besides the Wisconsin area, the lead regions of Iowa and Illinois. These latter districts taken together do not contain as much territory as the Wisconsin district alone.

The territory including the lead region of Wisconsin came into the possession of the United States in 1804 by a treaty with the Fox Indians. The land did not attract the notice of settlers until early in this century, but the lead had been known to the Indians, who made little if any use of it until the French taught them its value. Real activity in the mines began in 1822 when the general government took charge of the region and began granting land to operators. The rush of settlers kept increasing until it reached its maximum in 1829. The great excitement and enthusiasm of those early days, with the wild frontier life, was typical of a Rocky Mountain mining camp. The population was a changing and moving one. Numerous mushroom towns sprang up all over the district, and the towns remaining permanent were the exception rather than the rule. The rapid influx of miners finally resulted in trouble with the Indians, and out of this grew the Black Hawk War. This was characterized by the usual atrocities of an Indian war, but in spite of its unfortunate details, the war proved beneficial from an industrial point of view since it humbled the Indians and made the country known to hundreds of prospective settlers. Newspapers and pamphlets in the eastern states were filled with descriptions of the country and very soon a great tide of immigration began to

[1] A thesis submitted to the faculty of the University of Wisconsin, for the degree of B. L., June, 1900.

pour into northern Illinois and southern Wisconsin. So rapid was the growth that Wisconsin became an independent territory in 1836.[1] From this time on down to the middle of the century, there continued to be great activity in the mines. The maximum production was reached between the years 1845–47. The falling off in activity, commencing after 1848, was very probably due to the discovery of gold in California. About this time the miners began to leave and the activity in the lead region has never been so great as in former days.[2]

At first only the lead ores were utilized, but by 1860 the zinc came to be mined as well. In recent years there has been a revival in interest, and the future may see even greater operations when it becomes possible to make use of improved machinery.[3]

A region such as this, distinct from the rest of the state in its resources, and presenting such an interesting chapter in Wisconsin history, naturally creates a desirable field for study both for the geologist and for the historian. On its geological side the region has been very thoroughly studied, but from the historical and especially from the economic side, the study is far from complete. It is this latter phase which is the subject of the present paper. A small but well defined section in the lead region has been chosen with a view of studying its economic life and of trying to understand the conditions in a region with either a declining or stationary population. The study being a very limited one, few definite conclusions can yet be drawn, but it is proposed to state some of the problems and suggest a possible solution.

The region chosen for special study consists of nineteen townships in the counties of Grant and Lafayette. This group of townships is the oldest and at one time was the most active of all the lead regions. The seven towns of Grant county are Jamestown, Hazel Green, Potosi, Smelzer, Harrison, Platteville

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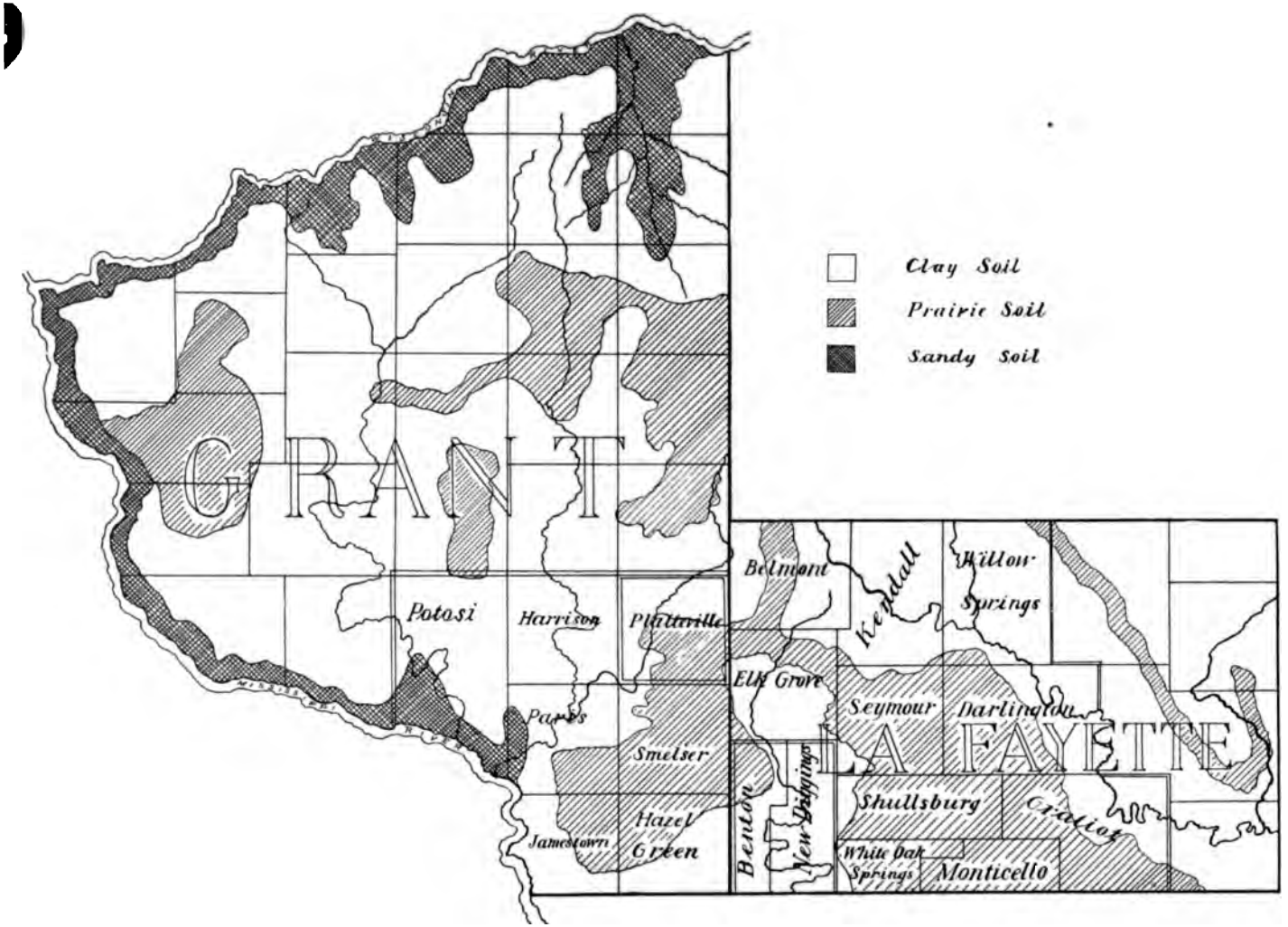
[1] Material for the history of the lead region may be found in Thwaites, Story of Wisconsin, and in the histories of Grant and Lafayette Counties; also, Thwaites, Early Lead Mining in Illinois and Wisconsin, American Historical Association, 1893, pp. 191-6.

[2] For a fuller discussion of these points see Libby, Significance of the Lead and Shot Trade in Early Wisconsin History, Wisconsin Historical Collections, XIII.

[3] See Milwaukee Sentinel, Nov. 5, 1899, for an excellent presentation of this phase of the matter.


Clay Soil
Prairie Soil
Sandy Soil
GRANT
Potosi
Harrison
Platteville
Belmont
Kendall
Willow Springs
Elk Grove
Seymour
Darlington
LA FAYETTE
Paris
Smelser
Hazel Green
Jamestown
Benton
New Diggings
Shullsburg
Gratiot
White Oak Springs
Monticello

and Paris.[1] The twelve towns of Lafayette county are Darlington, Shullsburg, Benton, Kendall, New Diggings, Gratiot, Elk Grove, Belmont, Willow Springs, White Oak Springs, and Monticello.[2]

In order to make such a study it is necessary to divide each county into sections so that comparisons can be made. In this division each county is taken separately. The following divisions have been made:

Group I. An area having the greatest number of lead mines. For Grant county, Platteville; for Lafayette county, Benton and New Diggings.

Group II. The general lead area consisting of the towns already named. For Grant county, seven townships; for Lafayette county, twelve townships.

Group III. A non-lead area, consisting of all the remaining townships in each county.[3]

It is necessary before going further to speak briefly of the geology and topography of this region.[4] It comprises the lead mining district of southwestern Wisconsin and is marked by no such irregularities of surface as are generally found in mineral districts. The important watershed commences at Madison and runs due west for twenty miles, southward for fifteen miles and then resuming its westerly course, terminates in the bluffs at the confluence of the Wisconsin and Mississippi rivers. The most noticeable thing about this watershed is its parallelism with the Wisconsin river so long as it holds a westerly course. The main western division of the watershed separates the waters flowing into the Platte and Fever rivers from those flowing into the Pecatonica. The waters of the Sugar and Pecatonica rivers are separated by the eastern division. The slope toward the south is very gradual and here the streams have eroded the country into undulating slopes where abrupt cliffs and ravines are the

[1] The area of this section is 265 square miles; the area of Grant County is 1,164 square miles.

[2] The area of this section is 431 square miles; the area of Lafayette County is 630 square miles.

[3] These townships are not entirely without lead; there are several having important lead mines in them; such townships are Lima, Beetown, Clifton, Wingville and Ellenborough.

[4] The material that follows was taken from Geology of Wisconsin, Vol. II., Part IV, 1873-77.

exception rather than the rule. The northern slope is steep, and the bluffs and ravines are rather mountanious in appearance, but this aspect marks the outer limits of the lead region.

The interior where the nineteen towns are located is marked by a rolling surface, and here most of the prairie land is found. This prairie region though comparatively small, a continuation of the Illinois prairie, comprises the townships of Jamestown, Hazel Green, Benton, New Diggings, Shullsburg, Seymour, Monticello and Gratiot. The waters of the streams, as well as of the mining ground, have decreased in quantity from early times, as a result of the removal of the timber and the cultivation of the land; but in spite of this the lead region is well watered, because of numerous springs and the great amount of annual rainfall.

South of the principal watershed the subsoil is clay with a thickness of from three to six feet. The lime, magnesia and alkaline earths in the subsoil and soil constitute, together with the vegtable mould, a soil in its virgin state, unsurpassed for richness and fertility. Exception to this clay soil is found in the eastern part of Lafayette county where there is much sand. Another important feature of the lead region is that it belongs to the driftless area, so that its surface is free from bowlders and pebbles. The subjoined map shows the location of the different soils in the two counties as well as the boundary lines of the three groups of townships already described.

Passing now to the consideration of the population, it is noticeable that in Group I and II there is a steady decline while in Group III there is either a stationary or an increasing population. The table below shows this clearly.

TABLE I.—*Population per square mile.*

	GRANT COUNTY.			LAFAYETTE COUNTY.		
	Group I.[1]	Group II.[2]	Group III.[3]	Group I.[4]	Group II [5]	Group III.[6]
1860	.....	46	21	69	32	19
1865	.....	48	23	68	36	23
1870	34	48	27	65	39	28
1875	.....	50	28	64	38	28
1880	34	47	28	58	36	28
1885	33	45	28	53	34	28
1890	28	43	28	48	32	30
1895	28	45	29	52	34	33

Group III has the least density except in Grant County, when in 1875 Group I falls below it. The density of the population in the towns of New Diggings and Benton is very striking.[7] In Platteville, the population of the village has been omitted in the table just given. It is very clear that the density of the population is greater in Groups I and II than in Group III but it is equally evident that the increase in population is always to be found in the last named group.

It now remains to determine what variations can be discovered in the property valuations per capita and the per capita of production for these three groups. The accompanying table shows the value of farm lands and live stock and of farm implements per capita.

[1] Platteville.

[2] Jamestown, Hazel Green, Potosi, Smelzer, Harrison, Platteville and Paris. Platteville township is thus twice counted, appearing in each group.

[3] Remainder of Grant County.

[4] Benton and New Diggings.

[5] Darlington, Shullsburg, Benton, Kendall, New Diggings, Gratiot, Elk Grove, Belmont, Willow Springs, White Oak Springs and Monticello.

[6] Remainder of Lafayette County.

[7] Different results would have been obtained if it had been possible to separate the village population from that of the rest of the town.

TABLE II.—*Value of farm lands per capita.*

	Grant County.			Lafayette County.		
	Group I.	Group II.	Group III.	Group I.	Group II.	Group III.
1860	135	128	180	81	61	258
1870	145	288	316	371	462	426
1885	220	381	335	460	571	484
1895	166	399	384	416	627	533
Value of live stock per capita.						
1860	18	21	32	15	28	42
1870	23	46	97	55	74	213
1885	49	79	103	60	132	152
1895	32	69	78	81	112	99
Value of farm implements per capita.						
1860	7	8	9	5	11	7
1870	6	12	20	11	18	17
1885	5	11	11	8	15	12
1895	3	9	10	10	11	8

NOTE.— The statistics of valuations and products for 1860 and 1870, were taken from the original records in the vault of the office of the Secretary of State. The Wisconsin State Census supplied the figures for 1885 and 1895. The valuation of personal and real estate would have made the study much more complete but it was impossible to find the material for earlier years. It was also impossible to obtain the valuations and products for each township before 1860, because the territory was divided into precincts in Grant County instead of into townships.

Group I shows a marked decline in the value of farm implements and a smaller per capita generally for the period of thirty-five years. In striking contrast to this is Group III which has the largest per capita of all the groups and has in many cases the greatest increase, also. This can not be due to any condition of the soil. The townships in Group I have a greater per cent. of fertile soil in them than those of Group III.

The statistics for the cereals, wheat, corn, and oats are rather difficult to consider as they vary greatly and show much irregularity. Two sets of figures are used, first those for the grown

crops of 1878, 1889, 1884, 1886, 1889, 1892, 1895 and 1897[1]; second, those for 1860, 1870, 1885, 1895.[2] The accompanying tables show the value per capita of these cereals for the various years.

TABLE III.—*Bushels of oats, per capita.*

	GRANT COUNTY.			LAFAYETTE COUNTY.		
	Group I.	Group II.	Group III.	Group I.	Group II.	Group III.
1878	27	46	42	44	109	61
1880	26	50	37	52	80	73
1884	27	55	57	61	86	67
1886	19	51	44	42	82	28
1889	37	61	78	55	100	65
1892	31	55	46	47	49	58
1895	18	47	45	20	43	17
1897	27	54	72	51	86	55
1860	24	21	23	14	36	25
1870	27	44	34	44	61	57
1885	29	65	62	72	102	70
1895	30	69	83	58	100	87

Bushels of wheat, per capita.

1878	1	4	10	3	2	3
1880	1	4	6	2	5	23
1884	2	4	6	2	3	4
1886	1	3	5	1	2	2
1889	.9	1	4	1	1	1
1892	.1	.1	4	.3	.4	1
1895	.1	1	1	.....	.....	.1
1897	.1	.1	1	.1	.....	.2
1860	9	10	28	10	22	22
1870	6	13	29	11	21	26
1885	2	5	7	2	3	4
1895	.8	8	3	.....	.1	1

[1] From the original unbound records in the vault of the office of the Secretary of State. They are given for each county by towns and by products, and the documents are arranged chronologically.

[2] The figures for 1860 and 1870 were obtained from the original records and those for 1885 and 1895 from the state census.

TABLE IV.—*Bushels of corn, per capita.*

	GRANT COUNTY.			LAFAYETTE COUNTY.		
	Group I.	Group II.	Group III.	Group I.	Group II.	Group III.
1878	41	71	71	68	100	79
1880	38	75	62	71	99	79
1884	26	56	61	73	89	65
1886	5	59	26	26	45	39
1889	27	57	68	56	88	59
1892	27	48	41	50	51	46
1895	13	33	28	22	41	25
1897	26	69	73	77	88	49
1860	11	20	32	9	24	29
1870	21	45	46	42	70	43
1885	28	72	73	92	111	87
1895	16	49	31	65	81	61

From the foregoing tables it can be seen that the conditions in Grant County from 1878 to 1897 were far less favorable even than those in Lafayette County. Group III shows as a rule the greatest per capita production of the cereals. The rise and decline in the wheat product for the three groups is very similar. Group I though showing in early years the least production of this grain comes in the years 1892, 1895 and 1897 to reach the same per capita as Group II. In corn and oats, also, Group I falls far below the other groups in per capita production, but all three groups show about the same rise and fall. For the period between 1860 and 1895, Group I has a rank not unlike that for the period just described. This group falls below the others, showing both the greatest decline and the least rise.[1] Group III shows the greatest per capita product in corn and wheat up to 1885 when it declines to second place.

In Lafayette County, 1878–97, Group III leads in its wheat product per capita. Group II takes first place in the production of corn and oats. For the period of 1860–95 the rise and fall of the per capita product is very similar and Group III leads in the wheat product only, a product of little importance.

[1] The sole exception to this statement occurs in the production of oats for 1880.

To sum up for the production of the cereals for both counties and for the two periods under consideration, Group I takes lowest rank in its per capita production of wheat, corn and oats. Group II has on the whole the largest production and shows the greatest increase. Group III, while below Group II in many cases, is far in advance of Group I though it shows the greatest irregularity.[1]

Passing now to the consideration of the butter and cheese products for these groups, the statistics may be found in the accompanying tables:

TABLE V.—*Pounds of butter per capita.*

	Grant County.			Lafayette County.		
	Group I.	Group II.	Group III	Group I.	Group II.	Group III.
1878	9	18	19	10	24	58
1880	8	22	25	16	30	54
1884	6	23	39	22	56	55
1886	5	20	39	19	32	51
1889	9	21	49	25	37	36
1892	.8	17	29	24	28	22
1895	10	25	34	2	30	36
1897	27	38	37	76	42	67

Pounds of cheese per capita.

1878	.9	1	2	.....	2	5
1880	1	1	2	.....	1	.2
1884	.5	1	4	.....	.1	21
1886	.....	.7	6	.....	.....	26
1889	2	3	8	.....	.1	34
1892	4	5	20	42	15	160
1895	.....	2	20	.....	9	177
1897	.....	2	29	.....	25	189

In the butter product, Group III in Grant County exceeds the others, except in 1897 when Group II has first place. Group I

[1] The differences between the tables for 1878-97 and for 1860-95 may be partly explained by the different methods employed in taking the census.

has the lowest rank throughout the period. After 1889 the fall in the per capita production in Group III is easily explained by the greater amount of cheese made between the years 1889 and 1897. The cheese product for Groups I and II can hardly be said to exist before 1886, and after 1895 it again disappears from Group I.

In Lafayette county Group III shows a marked decline in the per capita production of butter, but there is also a compensating rise in the production of cheese. Group II shows a greater increase in the production of butter then the same group in Grant County. Group I shows the smallest per capita production of butter up to 1892 when it exceeds that of Group III, but after a decline for the next three years, the butter product surpasses in amount that of the other groups. In Group I cheese appears as a product only between the years 1889 and 1892, but during this time it exceeds in amount the output of Group II.

It is clear from these facts that the cheese industry belongs to Group III and that butter making is an important business in all three groups, particularly in Group III.

In conclusion the results derived from the comparison of these three groups can be summed up in the following manner:

The towns of Group I still retain their density of population as in earlier days, yet this population is stationary or declining. The rich prairie land in which this area abounds has not brought the farm value anywhere near that of the rest of the county. The other valuations and in general all the farm products fall far below those of Group III, and even those of Group II. Group II has been able to counteract the early influence of its lead mines and its farm land has a higher value. The population in this group is as dense as in Group I and is declining at nearly the same rate. In valuation of farm lands and farm implements, and in per capita production of wheat and corn, this group slightly surpasses Group III.

Group III, composed almost entirely of non-lead-producing towns, and showing least density of population, has steadily increased in numbers and is the region of greatest progress. In valuations and farm products it far excels Group I and it has gained upon Group II in live stock, butter, cheese and wheat. It is very remarkable that Group III should show a greater per

capita in any product since the soil is not so fertile as that in the other groups.[1] Indeed the only very poor land in either of the counties is found in this group. Along the Mississippi and Wisconsin rivers extend wide tracts of sandy soil, which reach in many cases far into the interior. The only poor soil in Lafayette county is found in the eastern part, which is included in Group III.

The influence of the early lead industry is thus shown to be very important. The greater the importance of lead mining in early days the more marked the decline and stagnation in the economic life of the later period. Thus it is that the region least affected by the early lead mining industry has been able even under more unfavorable conditions of soil to show the greatest advance both in wealth and population. What the other influences are which differentiate these groups can not be determined until investigation has been made into the subjects of immigration and nationality and the still more difficult one of politics.

[1] There are some areas of prairie land in this group yet they are much smaller than those in the other groups.

CHAPTER III.

THE LEAD REGION OF ILLINOIS.[1]

BERNARD M. PALMER, B. L.

The lead region of Illinois is situated in Jo Daviess County, the extreme northwestern corner of the state. The mines found in this county were at one time among the richest in the world, and furnished great quantities of lead. But about the year 1850, when the mineral began to be found less abundantly, it became increasingly hard to work the mines on account of the water encountered at the lower levels to which the shafts had now been sunk, the industry declined, and after a period of years, nearly ceased altogether.[2] The purpose of this paper is to investigate the effect of the lead industry upon the life of the people in the region, along social, economic and political lines.

The lead mines of the Upper Mississippi river were early known to the French possessors of the country. As early as 1690 lead, obtained by the Indians, was an article of traffic with the French traders at Peoria.[3] The mines were held as crown property in accordance with the French custom, and were worked to some extent under various grants[4] between the years 1723 and 1745.[5]

Under British control the mines seem to have been as little worked as under French occupation, and it remained for the United States to fully develop them and obtain the benefit of the enormous wealth they contained. Although the richness of the mineral region of Illinois was a matter of common knowledge,

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[1] A thesis submitted to the faculty of the University of Wisconsin for the degree of B. L., June, 1900.

[2] Libby, Significance of the Lead and Shot Trade in Early Wisconsin History. Wisconsin Historical Collections, Vol. XIII.

[3] Senate Doc. 87, 29th Cong., 1st Session, p. 3.

[4] See notes on Early Lead Mining in the Fever River Region, by R. G. Thwaites, Wisconsin Historical Collections, Vol. XIII., pp. 276-7.

[5] Senate Doc., 87, 29th Cong., 1st Session, p. 3.

no actual surveys had been made, when on March 3, 1807, Congress passed an act entitled, "An Act Making Provision for the Disposal of the Public Lands Situate between the United States Military Tract, and the Connecticut Reserve, and for Other Purposes," the fifth section of which provided that the mineral lands of the United States should be leased for an annual rental, instead of being sold outright.[1]

This policy of the government, of reserving mineral lands from sale, was beneficial at the time of its passage, since it tended to prevent hasty and unprofitable disposal of rich mineral lands whose real value was unknown. But the system was continued too long, and became the cause of great injustice to the miners, and a source of constant trouble and expense to the government until it was abolished in 1846. Under this system, instead of selling the mineral lands outright, all tracts showing signs of containing possible lead bearing rock, were reserved by the government officers, from sale, but could be worked by any person who should register a claim with the Superintendent of Lead Mines, and pay, as an annual rental, a certain portion of the product, varying at different times from one-tenth to one-sixteenth, in pure lead or the money equivalent. But much trouble came to be experienced in collecting the rentals, after a few years, when the number of miners had greatly increased. Finally, matters fell into such a condition that the rentals received scarcely paid the cost of administration. The United States was compelled to carry on incessant actions at law to protect its property from trespassers. The leasing system also deprived the state of Illinois of the five per cent. to which she would be entitled should the lands be sold, as well as the taxes derivable from them when held as private property. But the greatest evil caused by the system, was the tendency toward an uneven development of the whole lead region. By it, all the land, except that containing mineral, was placed on the market in the regular way and bought by a class of people who speedily converted it into good farms. On the other hand, people who settled for farming purposes on land which the government agent, after a superficial examination had reserved as possible lead bearing land, were there as trespassers. Rather than risk a possible

[1] Laws of U. S., Vol. IV., p. 127.

ejection much valuable agricultural land remained unsettled till the leasing system was abolished.[1]

Only a few miners wandered into the region till after the war of 1812. Among the most famous of these was Julien Dubuque who settled on the site of the present city of Dubuque. He traded with the Indians in the whole region and bought lead from them during the period from 1788 to 1810, the date of his death.

On November 29, 1821, the control of the mines was transferred from the Treasury Department to the War Department, and the first leases under the Act of 1807 were granted the next year to parties from Kentucky, among whom was Col. James Johnson, whose brother was afterward vice-president of the United States. This may be said to be the beginning of the real activity of lead mining in the Northwest. The region was destined to become one of the most important and widely known in the West, profoundly affecting the life and economic conditions of the whole Mississippi Valley. While the lead lasted, this region was a center of interest, attracting attention from every direction. Settlement after settlement was formed, till the population in 1830 was over six thousand. Jo Daviess County was created in 1827 and included the entire district northwest of the Illinois river. The village of Galena grew from four log cabins in 1826 with a population of fifty people, to eighty buildings and three hundred people in 1830, and five hundred and fifty buildings and three thousand people in 1839.

Galena now became one of the most prosperous and best known cities in the Northwest. Steamboats coming up the Mississippi river from New Orleans and St. Louis, and down the Ohio from Pittsburg, landed on her wharves immigrants and miners from all parts of the United States and the world, and took away millions of pounds of lead and other products. This was the period before railway transportation had been developed. The steamboat was the quickest and most convenient

[1] For evils of leasing system, see: Annual Message of Pres. Polk, 1845; Ex. Doc. 1, 1st Session, 23d Cong.; Ex. Doc. 2, 1st Session, 24th Cong.; House Doc. 307, 2 1 Session 25th Cong. (by Brig. Gen. Worth); Ex. Doc. 3, 2d Session, 25th Cong.; Ex. Doc. 2, 1st Session, 26th Cong.

[2] Sen. Doc. 349, 1st Session, 26th Cong., Vol. VI.

means of transportation and the rivers were the great highways of commerce. This gave Galena enormous importance as the head of navigation and the distributing point for the whole lead region.[1]

Owing to the ease of communication by way of the river, the county was at first filled with a population largely southern in character. Many of these men brought their slaves with them to their new homes.[2] Later a New England element came in, and the conflict in ideas of these two classes furnishes an interesting study. A class of people of great importance were the Cornish miners who settled in the region and left their impress on the character of the whole population.

The time of greatest prosperity in the lead region was from 1835 to 1845. Money was plentiful, settlers were pouring in from the East, and all signs seemed to indicate that this section was to be the most important and influential one in the West. In common with other cities of the New West, Galena felt that her prosperity depended upon having a railroad. Public meetings were held, money subscribed, and on Nov. 8, 1854, the first train on the new road ran into Galena.[3]

Lead mining reached its height about the year 1845. After that date no new discoveries of any importance were made. The lack of effective machinery to work the lower levels, and the opening of the new California gold mines, drew from Jo Daviess County that class of enterprising adventurous men who had done so much to develop the country. The building of railways into the territory formerly supplied by Galena, decreased the importance of the city as a distributing center. The county was compelled to fall back upon agriculture for its prosperity. The thickly populated mining areas either decreased in population, or were deserted altogether. Cheap land in the new West led many of the vigorous young men to seek their fortunes there, and Jo Daviess County began to experience a decline in population and wealth from which it has never recovered.

In a report on the geology of the lead region written in 1860, Prof. J. D. Whitney says: "The lead bearing district of Illi-

[1] As many as fourteen steamboats were tied to wharves at one time. Northwestern Gazette and Galena Advertiser, Aug. 8, 1845.

[2] County Records: Deeds, Record A., p. 120, gives a bill of sale of a negro girl and child.

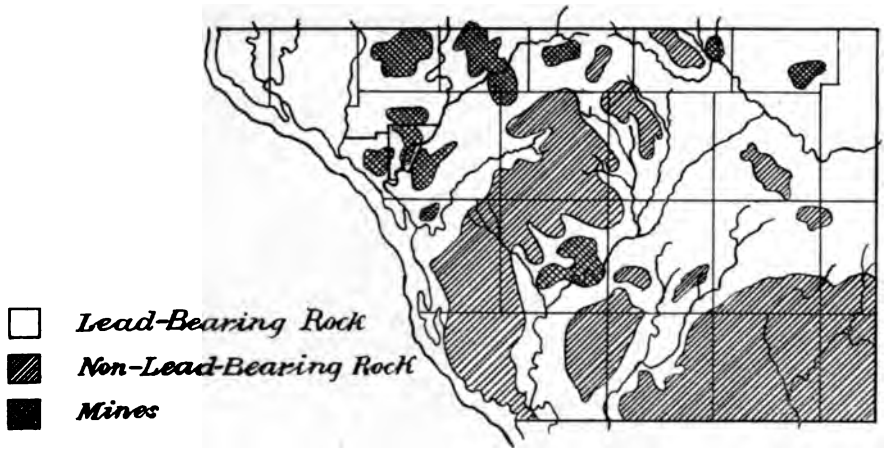
[3] Northwestern Gazette and Galena Advertiser, Nov. 9, 1854.

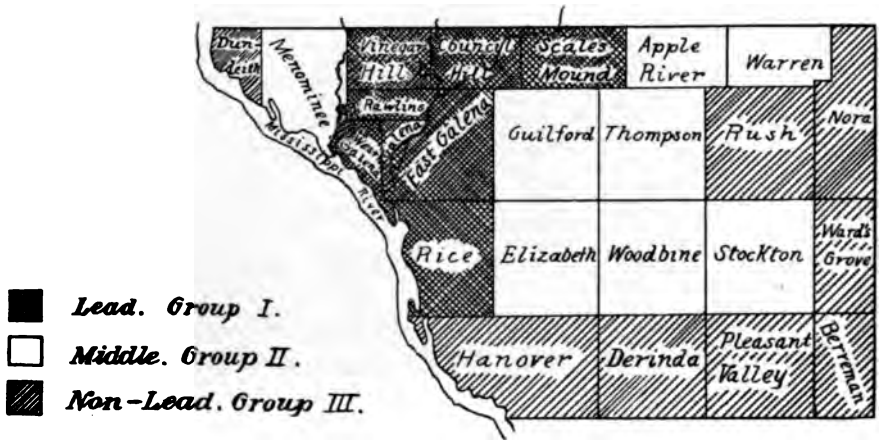
nois, in the northwestern corner of the state, forms a portion of the Upper Mississippi lead region, which occupies an extensive area in the three states of Wisconsin, Illinois and Iowa, where they corner with each other. The whole area over which lead has been raised, in sufficient quantity to be worthy of notice, is about 4,000 square miles, of which nearly two-thirds is in the state of Wisconsin and the other third about equally divided between Illinois and Iowa. The most productive portion of the region, however, is that which lies between Dubuque, Galena and Shullsburg, so that both Iowa and Illinois raise more lead, in proportion to the area over which mining operations have been extended, than Wisconsin does. It is quite impossible to give the exact amount for each state, as the imaginary line which separates Illinois from Wisconsin has no influence in the division of property or the supplies of ore furnished to smelting works. Some of the heaviest deposits of ore in Wisconsin are owned and managed by citizens of Illinois.

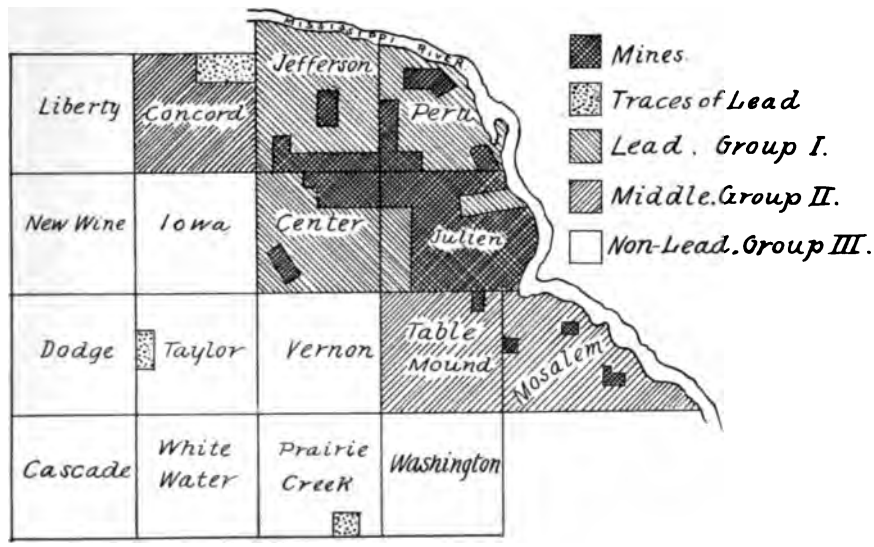
"The lead bearing district of Illinois is entirely comprised within the limits of Jo Daviess and Stephenson Counties, and by far the larger portion is in the first named county. Indeed, although ore has been found and mined, to some extent, in Stephenson County, and although the proper lead bearing rock covers a large area in that county, yet we are not aware of any diggings now in operation outside of Jo Daviess County. In fact, a circle of four miles radius, with its center a little northeast of Galena, would include nearly all the productive diggings, with the exception of those at Apple River and in the vicinity of Elizabeth; and certainly nine-tenths of the ore raised in Illinois comes from the area included within that circle of only eight miles in diameter."[1]

Map 1, Plate XXI., a reduced copy of one accompanying Professor Whitney's report, shows the distribution of the geological formations found in Jo Daviess County, and also the location of all the lead mines that have been successfully worked. The area on the map unmarked, is non-lead-bearing rock; in it lead has never been found in paying quantities. The land is valuable only for farming and stock-raising purposes. The area

[1] Geological Survey of Illinois, Vol. I., p. 155.


Lead-Bearing Rock
Non-Lead-Bearing Rock
Mines


Dun-leith
Menominee
Mississippi River
Hanover Hill
Council Hill
Scales Mound
Apple River
Warren
Rawline
Galena
East Galena
Guilford
Thompson
Rush
Nora
Rice
Elizabeth
Woodbine
Stockton
Ward's Grove
Hanover
Derinda
Pleasant Valley
Berriman
Lead. Group I.
Middle. Group II.
Non-Lead. Group III.


Mississippi River
Liberty
Concord
Jefferson
Perry
New Wine
Iowa
Center
Julien
Dodge
Taylor
Vernon
Table Mound
Mosalem
Cascade
White Water
Prairie Creek
Washington
Mines
Traces of Lead
Lead. Group I.
Middle. Group II.
Non-Lead. Group III.

marked with crosshatching on the map is the Galena Limestone, and except for a few patches of Blue Limestone along the Galena river, is the sole depository of the lead ore. By this statement is not meant that mines have been found in all portions of it, but that outside of it, in the unmarked area, no mines have ever been worked. By reference to the map, the grouping of the lead mines (shown in black) is readily seen. Certain districts were given over almost wholly to mining, while others were not affected by it. The location of the most important mines was as follows:[1]

1. The mines on Apple River, in Apple River and Warren townships.
2. The mines on Apple River in Elizabeth township.
3. The New California mines and diggings in Rice township.
4. The mines around the city of Galena in East Galena, West Galena and Rawlins townships.
5. The Council Hill and Vinegar Hill diggings.

Jo Daviess County has been divided into townships since 1853,[2] and for the purposes of this discussion, these townships have been divided into three groups. Townships of the first group include all townships where most lead mining was done, and where mining was the predominating industry. The second group comprises those towns where some mines were found, but where they did not assume so much importance as in Group I. The third group is composed of the rest of the county, and is the agricultural section. These groups shown on Map 2, Plate XXI., are the foundation upon which rests the structure of this investigation, and their significance must necessarily be kept in mind, to understand the conclusions arrived at.

The method employed for ascertaining the effect, if any, of the lead industry upon the locality where it was carried on was to examine township statistics on the subjects of population and the valuations of property as well as the records of votes cast on different measures during a series of years. The figures for the various towns were then placed in their appropriate groups, viz.: Group I (lead producing); Group II (middle); Group III

[1] See Geological Survey of Illinois, 1866, Vol. V., p. 45, also for detailed description and location of mines, same, Vol. I., pp. 201-207.

[2] History of Jo Daviess County, Chicago, 1878, p. 346.

(non lead producing), and an examination of the results was made.[1]

Great trouble was experienced in collecting the statistics for the townships. No material has ever been printed which contains the valuations and enumeration of property, as made by the various assessors, nor any record of the votes cast by the towns. It was necessary to go to Springfield and Galena and examine the manuscript records as they exist in the office of the Secretary of State at Springfield, and in the office of the County Clerk at Galena. The records in the Clerk's office were in a very disorderly condition and much searching and sorting of documents were necessary before the figures were made accessible. The records extend back in complete form as far as 1853, the date when township organization in the county was adopted, and the township lines established, practically as they are today. Before 1853 the county was governed by a board of three county commissioners,[2] and precincts of indefinite extent were the county subdivisions. Careful search among the records of Jo Daviess county failed to reveal the location of the boundary lines of these old precincts, or any statistics concerning them excepting the votes cast at various elections.[3]

As a consequence of this incompleteness of the sources, figures can be presented covering only the period since 1853. This is a period when lead mining had begun to decline, and we are able to study the relative effects of this decline on the various sections of the county. The questions will be considered in the following order:—First, population; second, valuations of property, as an index of relative changes in wealth; and third, the outcome of these influences, or in other word, the sentiments of the people as expressed in their votes on various questions.

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[1] The lead producing group, or Group I, consists of the following towns: East Galena, Council Hill, Scales Mound, Rice, Vinegar Hill, Rawlins, Galena and West Galena. Middle group, or Group II, consists of the following towns: Menominee, Guilford, Elizabeth, Apple River, Warren, Thompson, Woodbine and Stockton. Non-lead producing group, or Group III, consists of the following towns: Dunleith, Rush, Nora, Ward's Grove, Berreman, Hanover, Derinda and Pleasant Valley.

[2] History of Jo Daviess County, p. 344.

[3] See Maps in Appendix C for changes in town lines, 1854-90.

TABLE I.—*Population.*

These figures are taken from United States Census Reports. See Appendix C for the population of the several towns.

	Area in square miles.	Total Population.				Population Per Square Mile.			
		1860.	1870.	1880.	1890.	1860	1870	1880	1890
State of Illinois.....	56,550	1,711,951	2,539,891	3,077,871	3,826,351	30.2	44.8	54.3	67.5
State, except Cook County	55,750	1,566,997	2,189,925	2,470,347	2,634,429	28.1	39.3	44.3	47.2
Jo Daviess County.....	591.0	27,325	27,820	27,528	25,101	46.2	47.0	46.5	42.4
Group I.....	112.6	12,999	11,202	10,577	8,967	117.2	99.5	93.9	79.6
Group I, except Galena ..	108.8	4,803	4,183	4,126	3,332	44.1	38.5	37.9	30.6
Group II.....	259.3	9,031	10,509	10,568	9,983	34.8	40.5	40.7	38.5
Group III.....	220.7	5,295	6,109	6,383	6,151	24.0	27.6	28.9	27.9

Table I shows the movement of population in the state, in the county and in the three groups of the county.

It will be observed that from the year 1860 to 1890 there was a steady, consistent rise in the population, both of the state, including Cook County, and in the state outside of Cook County. The state outside of Cook County, while it started at 28.1 per square mile in 1860, rose to 47.2 in 1890. But Jo Daviess County, while it started in 1860 with a population of 46.2, instead of rising, fell to 42.4 in 1890.[1] Now let us examine the movement of population in the three groups. In Group I, outside of the city of Galena, the population started in 1860 at 44.1. This shows the densely populated condition of the lead mining areas. After 1860, the miners and the younger portion of the population left the country in swarms, and the result has been a steady, rapid decline, till in 1890 the population had reached 30.6 per square mile. From the table it will be noticed that in the second and third groups, where agriculture was the predominating industry, the region in 1860 was not so thickly settled as in Group I; yet they both enjoyed a continuous rise in population till 1880, and although they declined from 1880

[1] **The reason why the population per square mile of Jo Daviess County is high, is on account of the relatively large effect of Galena, where about 20 per cent. of the population of the county live on one per cent. of its area.**

to 1890, the decline was but slight compared with that which took place in the first group. This table and explanation, then, leads irresistibly to the conclusion that it was the decline in the lead industry that caused the decline in population in Jo Daviess County, and the figures in the table show at a glance the measure of this decline.

Having examined the relative movements of population in the various parts of Jo Daviess County, and having compared them with the state at large, let us now examine the relative movement of the property valuations in the same way, in order to obtain some idea of the wealth of the region. This we may do by examining the valuations as made by the various assessors.

TABLE II.—*Valuation per capita.*

The figures in the table include both real and personal property and exclude all railway property. The figures for the state are taken from the printed reports of the state auditors. The figures for the groups of Jo Daviess County are compiled from the original collector's book in the vault of the County Clerk's office at Galena. The record of each township is kept in a separate book for each year.

	1860.	1870.	1880.	1890.
State	$208.15	$182.00	$239.50	$189.00
State, except Cook County	203.20	173.00	250.00	204 00
Jo Daviess County	123.10	119.85	170.68	157.71
Group I	124.54	102.57	120.66	102.24
Group II	113.88	125.35	194.50	184.10
Group III	135.45	142.04	214.13	195.77

The striking fact shown by the above table is the decline of the valuations in the lead region. Starting at a point above the middle area, they fall rapidly from 1860 to 1870, although for the other two portions of the county they rose during the same period. In common with the rest of the state, the valuations in the lead region rise from 1870 to 1880 on account of the higher assessments of the latter year, but the rise is by no means as great. And, finally, we notice that the decline from 1880 to 1890 is greater in the lead area than in the other two. It should be noticed that the figures for the lead group vary but little. So we find that in valuations, also, the lead region of Jo Daviess County is an area peculiar and distinct from the areas that surround it.

The only figures available for the nativity of the population of Jo Daviess County are given in the Federal Census Report and are for the year 1870. They are as follows:

TABLE III.—*Nativity in 1870.*

	Native.	Foreign born.	Per cent. foreign.
Jo Daviess County	19,966	7,854	28.3
Group I	7,213	3,989	35.5
Group II	7,975	2,734	26.0
Group III	4,978	1,131	18.2

These figures show the greatest proportion of foreign born to be in the lead, and the least in the non lead producing areas. The tendency was for a native born population to settle on the farming lands, while miners from Cornwall and other portions of Europe settled in the mining region.[1]

The most important of our problems is that which deals with the political affiliations of the population. So many elements enter into the problem that it is extremely hazardous to arbitrarily include certain influences and exclude others. But by taking a great number of votes and combining them for a series of years, local and personal considerations may be eliminated.

Table IV shows the combined result of all the votes cast for the Republican and Democratic candidates for both president and member of Congress, from 1856 to 1896. From this table it is seen that the northwestern portion of the county is most strongly Democratic in character, and when we consider the measures advocated by that party for the last forty years, this fact comes to have great significance. The lead region, with the strongest southern and foreign influence was thus also most strongly Democratic, 53 per cent. of the total vote of this group being cast with the Democratic party, while Group III, settled by farmers from New England, cast 65 per cent. of their vote with the Republican party.

[1] Copeland, The Cornish in Southwest Wisconsin, Wisconsin Historical Collections, Vol. XIV.

TABLE IV.—*Vote for presidential electors and congressman 1856–1896.*

	REPUBLICAN.		DEMOCRATIC.	
	Vote.	Per cent. of total.	Vote.	Per cent. of total.
Group I	19,333	47	21,769	53
Group II	22,831	59	15,236	41
Group III	13,863	65	7,420	35
Total	56,027	Av. 56	44,425	Av. 44

Table V shows the combined vote on two measures for township organization taken April 4, 1854, and April 7, 1857.[1] The votes here taken were in accordance with the state law, which allowed any county governed under the precinct system, to change to the more regular and perfect system of organization by townships. The precinct system was a relic of the connection of Illinois with Virginia;[2] it was loose and easy working in its action, but it did not appeal to the more strict and careful ideas of governmental administration entertained by the New England men who came into the county from 1840 to

TABLE V.—*Vote on township organization.*

	FOR		AGAINST	
	Vote.	Per cent. of total.	Vote.	Per cent. of total.
Group I	685	60.5	445	39.5
Group II	901	78.0	255	22.0
Group III	674	92.7	53	7.3
Total	2,260	Av. 75.0	753	Av. 25.0

1850. They made several attempts to substitute the township for the precinct system, and finally succeeded in doing so, although the influence of the southern element in the population was strong enough to make Jo Daviess the last county north of the Illinois River to adopt the township system.[3] The

[1] The statistics for these votes are taken from box 110 in the vault of the County Clerk in Galena.

[2] History of Jo Daviess County, p. 346.

[3] Ib., p. 347.

chasm between the lead region and the other groups reveals itself in this vote. Practically all the opposition to township organization comes from the principal lead region. This region supplies the supporters of slavery and the old precinct system of county organization, while the non lead producing section, with its farming population favored the township system, and also voted with the Republican party.

On Nov. 4, 1862, the people of Illinois were called upon to vote on the question of adopting a new constitution for the state. Among several measures on which a separate vote was to be taken was a proposition to exclude negroes and mulattoes from Illinois.[1]

The vote on this measure, the results of which are given in Table VI, clearly shows the location of the pro-slavery feeling. Group I is quite largely in favor of excluding the negro, while Group III, the agricultural region in the eastern part of the county, has a much larger per cent. of voters against the proposal.

TABLE VI.—*Vote on question of excluding negroes from Illinois.*

	For		Against	
	Vote.	Per cent. of total.	Vote.	Per cent. of total.
Group I	1,063	75.0	346	25.0
Group II	821	68.0	385	32.0
Group III	419	55.5	332	44.5
Total	2,303	Av. 68.5	1,063	Av. 31.5

In Table VII we have the result of a vote on three propositions for allowing animals to run at large on the highways of the county. The first vote was taken Nov. 5, 1872,[2] the second April 6, 1875,[3] and the third April 5, 1887.[4] The vote taken

[1] The statistics of this vote were found in box 113 of the vault in the office of the County Clerk, Galena, Illinois.

[2] Ibid., box 113.

[3] Ibid., box 113.

[4] Ibid., box 526.

periodically on this question furnishes a good index of the condition of the people. The significance of the vote may best be indicated by quoting from a personal interview with the County Clerk, the Hon. William Rippin, who has served the county for many years. He said, "The owners of waste land and the poor people were in favor of allowing animals to run at large, while the farmers who had all improved land were against it. The owners of waste land and the poor people in the towns were in favor of the proposition; the poor people, because they could pasture on the highways, and the owners of waste land because they could let their cattle run loose on their waste land, thus saving the cost of fencing. The reason why the farmers owning all improved land were against the proposition, was because they preferred to build a pasture fence for what stock they chose to keep, and allow the rest of their land to go unfenced. Should the animals be allowed on the highway, it would compel them

TABLE VII.—*Votes on proposition for allowing animals to run at large.*

	For		Against.	
	Vote.	Per cent. of total.	Vote.	Per cent. of total.
Group I	2,436	59.0	1,669	41.0
Group II	3,875	47.5	4,216	52.5
Group III	1,655	36.0	2,932	64.0
Total	7,966	Av. 47.5	8,817	Av. 52.5

to keep all their land well protected by fences." Bearing these facts in mind, it is seen from the table that the lead region and the towns along the river, except Menominee, took the side of the poor man and the waste land owner, while the region away from the river, the agricultural area, just as uniformly took the opposite view.

To sum up briefly, we have found in our investigation that two distinct areas exist in Jo Daviess County: the first one where lead mining was once important, and the other where agriculture has always been the important industry. The lead region is the lowest in population and in valuations, is different from its neighbors in politics, being mostly Democratic, and the

majority of its inhabitants are either of foreign or (probably) of southern birth. The other region is one of no lead, is largely agricultural, has an increasing population made up largely of New Englanders, favors the Republican party, and assumes a less pronounced attitude on the negro question. It thus appears that to study the development of political life in a given locality it is important to study the economic conditions which so powerfully influence the political opinions of the people.

CHAPTER IV.

THE LEAD REGION OF DUBUQUE COUNTY, IOWA.[1]

ALLARD J. SMITH, B. L.

The student of history can find few themes of more interest than the migrations of peoples to new regions and the exploitation of mineral land. Some fifty years ago thousands left the Eastern states and settled in California, drawn thither by the discovery of gold, and in more recent years the same thing has taken place in Southern Africa. It is not generally known, however, that in our own neighborhood, in southwestern Wisconsin and across the Mississippi in eastern Iowa, something of the same kind occurred, only on a much smaller scale. The discovery of lead caused immigration into these regions and it is the purpose of this paper to investigate some of the effects of the influence of the resulting industry in eastern Iowa.

The French once owned all this vast domain, from the St. Lawrence to the mouth of the "Father of Waters," but they showed here, as elsewhere, that they were failures as colonists. They built forts at Detroit and St. Marie and, true to their practice, they built a line of forts from Prairie du Chien to the Gulf of Mexico. The fort at Prairie du Chien was built in 1740, but this vast country passed into the hands of Spain before Dubuque came to this region. In 1788, at a council of chiefs of five Indian villages at Prairie du Chien, Julien Dubuque received a permit "to work the mine as long as he shall please and to withhold from it, without specifying any term to him; moreover, that they sell and abandon to him all the coast and the contents of the mine discovered by Peosta,[2] so that no white man nor Indian shall make any pretension to it without

[1] A thesis submitted to the faculty of the University of Wisconsin for the degree of B. L., June, 1900.

[2] Peosta was Julien Dubuque's Indian wife. She was a full blooded Indian and the daughter of the chief.

the consent of Mr. Julien Dubuque; and in case he shall find nothing within, he shall be free to search wherever he may think proper to do so, and to work peaceably without any one hurting him or doing him any prejudice in his labor.[1]

Dubuque began mining at once with a force of ten men, and in 1795 he got a confirmation of this title by the governor of Louisiana, Baron de Carondelet. But, through negligence, this was never confirmed by the king of Spain, so that his claim to the Spanish mines, extending sixteen miles along the river and as far back as the mines went, including in all about seventy thousand acres, was defective and the part that he sold to Auguste Chosteau in 1804 was retained by the United States, and the part unsold reverted to the United States in spite of the protests of his heirs.[2]

In 1810 Julien Dubuque died and his settlement was abandoned and remained so for nearly twenty years on account of the incessant Indian warfare. But in 1827, Galena was incorporated and many settlers were attracted there by the lead, and a few of the hardier ones crossed the Mississippi to Dubuque, or as it was known then, the Spanish Mines, and there settled as miners.

The people brought together by the discovery of valuable minerals, whether in Australia, Africa or America, have generally settled in the regions to which they emigrated before the advent of any government, and consequently the miners were obliged to make a temporary government for themselves. Dubuque proved no exception, and in 1830, under the lead of J. L. Langworthy, the miners, having previously obtained permission from the Indians to work the mines, met about an old cottonwood log near the banks of the Mississippi River and proceeded to enact a miners' agreement. They affirmed that they would be governed by the regulations in force at the Galena mines on the other side of the river, excepting that each man was to hold two hundred yards square of ground by working one day in six, and also that an arbitrator, to be elected by them, was to settle all disputes.

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[1] Picard, Dubuque in Territorial Days, Iowa Historical Record, Oct. 1899, p. 542.

[2] See United States Supreme Court Case of Chosteau vs. Maloney, 16 Howard, 203.

They had been at work but a few months when the United States government stepped in and sent a body of troops from Prairie du Chien to move the settlers back across the Mississippi. In 1832, at the close of the Black Hawk War, when the Sacs and Foxes ceded a strip forty miles wide from the upper Iowa River to the northern boundary of Missouri; the miners returned but were again driven back. In the year 1833 the troops were withdrawn and the United States government took control of the land. They reserved all mineral lands from sale and leased the mines to the individual. This system was soon discontinued, but not until 1839 were the titles to mineral lands secure.

During this period many people, drawn hither by the great richness of the mines, came to Dubuque. At first this mining area was called the Spanish Mines, and later the Dubuque Mines. These names did not seem to give any hint of civilization, nor were they in accord with the dignity of the place. So by a vote of the citizens this lead mining district of Iowa was called Dubuque.

In 1834 the district had increased largely in size and was peopled, so far as we were able to discover, by the usual mining class. In 1836, the year in which territorial government went into operation, Dubuque had a town site platted and the next year the village was incorporated. At their first election, when the community had a population of about thirteen hundred, six hundred and twenty-one votes were polled, showing that a majority of the citizens were men of voting age. That this region was growing with wonderful rapidity is attested by the incorporation of Dubuque under a city charter four years after it was incorporated as a village. By 1846, the year Iowa was admitted to statehood, Dubuque was no longer a detached settlement on the frontier, but an important center of population and trade in a well-ordered commonwealth. With this date we may bring our historical sketch to a close.

In this, as in other mining regions, the surface of the land gives to a tyro no inkling of the wonderful possibilities beneath the exterior. Peru, Julien, Jefferson and Center Townships, those in which great quantities of lead were found, extend about twelve miles along the river and back about the same distance.

Julien Township, on the river, is a very broken and hilly country, in fact, it is made up almost entirely of high bluffs and deep ravines, and was, before the time of the settlers, heavily timbered land. Peru, also on the river, is of much the same character as Julien; great quantities of lead were found here. In fact, Dubuque, in Julien Township, was built up by the lead trade. Center and Jefferson Townships, which next to Peru and Julien produced the greatest quantities of lead, belong naturally together. The land here is broken as in Julien and Peru, but is still very hilly. Center is quite heavily timbered, while Jefferson is not; otherwise they are very much alike. These four townships produced the greatest quantities of lead, and as this paper seeks to show the results of the lead trade by differentiating the lead producing and non lead producing areas, they may be considered as forming one area. Liberty, New Wine, Iowa, Dodge, Taylor, Vernon, Cascade, Whitewater, Prairie Creek and Washington townships show no lead at all, or at most, a mere trace of it, and they form together what we shall call the non lead producing area. Liberty, New Wine, Dodge, and Cascade Townships have soil of an average kind and not the slightest trace of lead. Whitewater and Taylor are each about half broken timber land and half prairie and each has a trace of lead, but none of any importance. Iowa and Washington have clay soil, no timber, and are somewhat hilly, while Prairie Creek and Vernon have unbroken, sandy, prairie land. Between these two divisions we have a third, composed of those townships which are neither mining nor farming areas, but are a mixture of the two. In this class we will put Concord, Table Mound and Mosalem. Mosalem Township, on the river, is made up of broken land. Some lead was mined here, but it was not found except near the river, and then in no very great abundance. Table Mound had good mining lands in the extreme northern part, but more than two-thirds of the township has clay or sandy soil. Concord had mines in the northeastern quarter of the township, but the rest is hilly, with soil of the average kind and no trace of lead.[1]

[1] The foregoing description is taken from R. D. Owen's Report on Lead Region. Sen. Docs., 28th Cong., 1st Sess., Vol. 7, 1843-44.

Thus we see that we have divided the county into three natural divisions. For the purposes of this paper we will consider the region of maximum lead production as Group I. The intermediate region as Group II, and the region which produces practically no lead as Group III. The subjoined map shows the divisions just described and gives also the location of the lead mines—those portions of the map heavily shaded. It is seen that there were a great many mines in Julien, Peru, Jefferson and Center Townships, a few in Mosalem, Table Mound and Concord, and only one or two of minor importance in our great non lead producing area.

Immigrants poured into this region early and it developed fast. There were settlers here in 1833, and by 1852 the township organization had been effected. It is unfortunate that no well tabulated census report can be found for the period before 1852, for it was then that the region, especially in the lead area, developed most rapidly. There were no mines being developed elsewhere at this time to draw off the population as there were after 1849 when gold was discovered in California, nor was there any war such as the great Civil War to drain this country of her busy workers.

TABLE I.— *Population per square mile.*

Compiled from Census of Iowa, 1880 and 1895.

	Group I.		Group II.	Group III.
		Excluding Dubuque and Julien townships.		
1852	36.6	14.7	17.6	10.7
1856	77.4	27.0	25.0	16.6
1860	86.2	31.3	32.0	27.3
1865	97.2	31.3	26.4	28.5
1870	111.0	32 5	31.2	33.9
1875	134.6	35.1	30.5	37.6
1880	123.8	36.7	32.8	31.7
1885	132.4	34 0	29.9	32.7
1890	155.3	34.0	28.4	35.8
1895	199.6	32.3	23.2	41.6

It was found impossible to separate Dubuque and Julien, and so they were both omitted in one case and included in the other. Dubuque had such an enormous increase in population from causes other than the lead trade that if it were included, the tables of population per square mile would not correctly represent the actual situation. From the table it is seen that the population in Group I grew very slowly from 1850 to 1880. We know that the lead industry was on the decline during the same period, and when it is remembered that the discovery of gold in California took place just before this, we see that the

For map of Iowa, see plate XXI, p. 213.

mediate or middle area, seems to have been an unstable one. The population per square mile in 1860 was greater than it was at any subsequent time until 1880, after which there came another decline. This may be attributed to the war and also to the exhaustion of the lead mines of this region. The mines in this middle area were not very numerous nor were they particularly rich in mineral, so that they were not opened till the mines in the most productive region had all been opened, and in many cases worked out. The mines of the middle area were, therefore, soon exhausted and this fact, combined with the breaking out of the war in 1860, caused the moving of many families from these regions. Then later came the impetus toward agriculture and a slight rise in population; but there were better lands not far distant, so that the population did not long remain at its high stage, but rapidly declined.

Group III, our non lead producing area, was settled rapidly and rose suddenly in population during the period of 1860–75. At this time there seems to have been a slight decline, but in 1895 it had fully recovered and stood first.

Population and wealth go together. We have prepared a

table of per capita values for the period 1875–95. The figures were obtained from the assessors' returns on file in the office of the Auditor of Dubuque County. The books containing figures previous to 1875 could not be found.[1]

TABLE II.—*Per capita of total property valuations.*

For 1880 the figures for personal property alone are given.

	Group I. [Excluding Dubuque.]	Group II.	Group III.
1875	99.0	99.7	124.9
1880	23.0	136.3	34.7
1885	117.5	161.7	237.4
1890	142.3	135.9	176.5
1895	143.5	184.7	212.5

We see by this table that the lead region by 1875 had already passed its period of most rapid development and was increasing in wealth and numbers more slowly than the rest of the county. In twenty years the wealth per capita of this lead area increased only from $99.0 to $143.5, while in the middle area the increase was from $99.7 to $184.7, and in the non lead producing area from $124.9 to $212.5. After the land had been worked for mines it was as a rule fit for little else, and with the exhaustion of the mines came decline in population and wealth per capita for these regions, as already shown.

The comparative strength of the political parties in these three areas may be seen from the following table which shows the vote in Dubuque County for president from 1860 to 1896, and the vote for governor in 1854 and in 1857. In the first column are the total number of votes cast, either Democratic or Republican. In the second column is given the per cent. of the total cast for the Democratic and Republican candidates, respectively. The figures for the city of Dubuque are omitted from this table.

[1] It was a task of considerable difficulty to collect these valuation figures. The figures for each town are recorded in a separate volume and many of these volumes are missing. The auditors have made it a practice never to keep any census report longer than ten years. After that time the reports are stored in the basement of the court house.

TABLE III.—*Votes in presidential elections 1860–96. Gubernatorial elections of 1854 and 1857.*

	GROUP I. [Excluding Dubuque.]				GROUP II.				GROUP III.			
	Total vote.		*Per cent. of total.*		*Total vote.*		*Per cent. of total.*		*Total vote.*		*Per cent. of total.*	
	Dem.	Rep.	Dem.	Rep.	Dem.	Rep.	Dem.	Rep.	Dem.	Rep.	Dem.	Rep.
1854..	111	35	76	24	108	50	69	31	392	215	65	35
1857..	113	20	85	15	162	41	80	20	577	317	65	35
1860 .	282	147	67	33	222	69	77	23	1,211	632	65	35
1864..	370	161	67	33	361	102	78	22	1,364	532	72	28
1868..	395	236	63	37	391	108	79	21	1,669	720	70	30
1872..	360	212	64	36	299	115	73	27	1,381	618	70	30
1876..	477	133	80	20	485	162	71	29	1,730	671	73	27
1880..	429	143	76	24	422	105	81	19	1,844	693	73	27
1884..	529	213	72	28	417	187	70	30	2,114	640	77	23
1888..	505	197	72	28	371	172	69	31	2,178	523	81	19
1892..	439	107	81	19	415	153	74	36	2,099	639	77	23
1896..	408	173	71	29	411	197	78	22	2,074	831	70	30

If we examine these votes by townships[1] we shall find that only one of them, Taylor, goes Republican from 1852 to 1896, and that three, Dodge, Cascade and Whitewater, are divided, usually going Democratic. The rest of the county is Democratic by large majorities.

In the votes of the lead producing area we can see the opposition of the river element to the policy of prohibition, important for a part of this period in the Republican party. There is here, too, plainly enough the influence of the South on the river towns. Groups I and II show a greater fluctuation in their Democratic majorities than does the third group.

In summarizing the conclusions so far reached we may say that the lead region of Dubuque County had at first a very rapid growth in numbers and in wealth, but as the mines gave out the people of enterprise began to move away, so that today the region is not so prosperous as formerly. The city of Dubuque, indeed, took its rise from the lead trade, but as this occupation de-

[1] See Appendix D, table IV.

clined in importance, she was able, on account of her good harbor and fine location, to turn her attention to other lines of business and to continue as prosperous as ever.

The middle area in Dubuque County was neither an important lead producing section nor a good farming region, so that after its mines were exhausted it declined in importance.

The non lead producing area was settled last, but it has grown rapidly and steadily ever since settlement. The wealth of the county centered at first in the lead area. In 1875 the middle area had equalled the lead area, while the non lead producing area had outstripped them both. In 1895 the third area had a per capita valuation of $212.5, the middle area $184.7, and the lead area $143.5.

Along with this change in relative rank in population and wealth, these three areas show certain parallel differences in political affiliations. The third area has always been more Republican, while the lead and middle areas had just as strongly a Democratic tendency. Thus is shown the influence of economic factors upon social and political life.

APPENDIX A.

The population table in this appendix was compiled from the figures found in the various blue books of the state and also in the history of a state or county only after a careful study of local conditions.

The valuations for 1885 and 1895 were taken from the state census reports for those years.

The statistics regarding farm products for 1877–97 were obtained from the unbound reports of grown crops, filed in the vault of the office of the Secretary of State. In case of certain towns in Grant and Lafayette counties, for which figures are given in Appendix B, Miss Stanton's figures were used without verification. All the material of this last sort has never yet been published by towns.

TABLE I.— *Population by towns, 1860–95.*

Grant County.	1860	1865	1870	1875	1880	1885	1890	1895	Area in square miles.
Beetown	1,482	1,740	1,624	1,717	1,530	1,301	1,257	1,130	.....
Clifton	958	877	1,076	999	1,078	1,073	1,074	1,044	.....
Platteville	2,682	3,039	3,683	4,060	3,813	3,877	3,687	4,253	.....
Potosi	2,081	2,754	2,686	2,644	2,375	2,147	2,110	2,061	.....
Total	7,203	8,410	9,069	9,420	8,796	8,398	8,128	8,488	175
Remainder of Grant Co.	24,014	25,208	28,806	29,666	29,056	28,879	28,523	29,884	989
Iowa County.									
Dodgeville	2,180	3,622	3,708	3,725	3,540	3,492	3,299	3,682	.....
Highland	2,409	2,656	3,016	3,024	3,345	3,240	3,284	3,298	.....
Linden	1,645	1,794	2,054	2,059	1,996	1,985	1,861	1,397	.....
Mifflin	1,220	1,196	1,490	1,526	1,529	1,398	1,465	1,557	.....
Mineral Point	3,623	3,808	4,825	4,581	4,405	4,309	3,965	4,381	.....
Ridgeway	1,982	2,437	2,489	2,473	2,348	2,531	2,331	2,454	.....
Total	13,159	15,513	17,582	17,388	17,163	16,955	16,205	16,769	515
Remainder of Iowa Co.	4,638	5,144	6,962	6,745	6,455	4,917	5,912	6,678	225
Lafayette County.									
Benton	2,089	1,971	1,723	1,681	1,519	1,417	1,245	1,458	.....
New Diggings	1,689	1,726	1,794	1,805	1,641	1,482	1,374	1,325	.....
Shullsburg	2,491	2,718	2,702	2,540	2,244	2,197	2,270	2,155	.....
White Oak Springs	513	528	540	446	451	449	384	433	.....
Total	6,782	6,943	6,759	6,472	5,855	5,545	5,273	5,371	106.5
Remainder of Lafayette Co.	11,359	13,405	15,900	15,697	15,423	14,922	14,992	16,117	513.5

TABLE II.— *Bushels of wheat, by towns, 1877–97.*

	1877	1880	1882	1886	1889	1892	1895	1897
Grant Co.	263,800	225,574	155,960	169,840	131,170	137,261	47,492	104,271
Beetown	2,035	1,980	932	4,941	2,078	1,555	722	2,617
Clifton	6,398	8,012	6,000	5,468	3,620	4,820	960	1,904
Platteville	2,773	4,812	7,723	4,900	3,360	4,370	435	1,625
Potosi	9,270	13,835	7,800	7,915	5,560	3,635	599	2,598
Total	20,476	28,639	22,455	23,224	14,618	14,380	2,716	8,804
Remainder of Grant Co.	243,324	196,935	133,505	146,616	116,552	112,881	44,776	95,471
Iowa Co.	261,000	201,839	141,394	117,915	75,494	80,821	38,305	61,612
Dodgeville	37,608	31,368	17,762	12,894	7,221	6,642	4,471	12,125
Highland	48,966	25,274	18,667	30,860	12,254	15,875	10,510	12,361
Linden	13,720	9,950	7,226	3,907	1,240	2,490	50	1,537
Mifflin	5,926	8,889	3,410	2,235	492	387	.....	508
Mineral Point	10,222	12,355	9,388	4,806	4,674	2,461	1,090	679
Ridgeway	45,795	24,019	19,900	11,536	14,133	9,180	1,658	5,946
Total	162,237	111,855	76,353	67,237	40,014	37,035	17,779	33,156
Remainder of Iowa Co.	98,763	89,984	65,041	49,678	35,480	43,786	20,526	27,457
Lafayette Co.	34,440	212,537	59,324	49,487	27,626	14,255	1,334	9,793
Benton	4,199	2,623	1,500	1,864	839	530	.....	386
New Diggings	1,100	5,852	5,180	3,205	1,790	450	.....	275
Shullsburg	1,050	3,214	1,304	1,397	625	.....	.....	.....
White Oak Springs.	.....	1,700	1,523	359	936	50	.....	633
Total	6,349	13,389	9,507	6,825	4,190	1,030	.....	1,294
Remainder of Lafayette Co.	28,091	199,148	49,817	42,662	22,436	13,225	1,334	8,499

TABLE III. — *Bushels of corn, by towns, 1877-97.*

	1877.	1880.	1882.	1886.	1889.	1892.	1895.	1897.
Grant Co.....	2,428,444	2,520,998	2,308,631	1,378,618	2,394,132	1,646,364	1,153,252	3,284,818
Beetown..	49,000	81,000	49,650	81,040	66,720	47,745	34,925	194,531
Clifton	77,748	109,740	85,200	54,875	83,755	74,380	31,405	115,200
Platteville	118,462	147,780	80,480	20,293	102,325	103,155	59,425	123,550
Potosi.....	141,285	235,060	120,670	67,670	107,940	64,075	86,375	181,350
Total.....	386,495	573,580	336,000	223,878	360,730	289,355	212,130	614,631
Remainder of Grant Co.. ...	2,041,949	1,947,418	1,972,631	1,154,740	1,933,402	1,357,009	941,122	2,670,182
Iowa Co.....	1,374,277	1,826,898	1,216,948	747,854	1,136,400	805,514	726,160	1,443,802
Dodgeville.....	134,465	120,550	95,875	55,100	58,650	41,311	69,860	146,950
Highland	113,485	93,230	97,550	67,200	45,711	46,666	59,285	95,075
Linden.....	219,900	151,200	149,740	89,362	144,810	105,600	79,775	161,335
Mifflin.....	162,698	165,750	150,000	55,620	97,200	102,365	48,135	172,290
Mineral Point.	125,645	147,515	136,347	79,040	97,625	89,771	52,165	50,845
Ridgeway.....	140,740	152,996	145,210	106,838	153,245	125,420	135,465	146,070
Total.....	896,928	831,570	774,722	453,160	597,241	511,133	444,685	772,615
Remainder of Iowa Co.....	477,349	495,328	442,226	294,694	539,159	294,381	281,475	671,187
Lafayette Co....	3,404,367	2,010,545	1,896,292	887,697	1,624,853	1,010,258	785,304	2,139,094
Benton	128,308	156,190	160,000	45,205	100,920	95,725	37,415	137,700
New Diggings.	76,000	69,360	77,950	38,098	47,950	35,300	26,100	85,750
Shullsburg....	187,495	173,900	136,650	74,960	94,500	112,150	137,500	144,250
White Oak Sp.	59,200	100,800	56,455	41,280	59,900	26,500	26,530	97,175
Total.....	451,003	500,250	431,055	199,541	303,270	269,675	227,595	464,875
Remainder of Lafayette Co..	2,953,364	1,510,295	1,465,237	688,156	1,321,583	740,583	557,709	1,674,219

TABLE IV.— *Bushels of oats, by towns, 1877-97.*

	1877.	1880.	1882.	1886.	1889.	1892.	1895.	1897.
Grant Co.... ...	1,880,631	1,598,021	1,823.445	1,743,239	2,760,346	1,807,209	1,777,042	2,829,703
Beetown.....	27,613	49,774	43,486	77,146	59,290	59,245	38,985	108,085
Clifton.....	80,664	68,712	63,400	77,328	131,005	118,700	60,245	111,730
Platteville....	101,046	99,270	73,405	74,638	137,835	115,745	80,655	102,700
Potosi.....	83,950	103,094	139,321	89,815	114,096	84,015	62,635	131,060
Total.....	293,273	320,850	319,612	318,977	442,226	377,705	242,520	453,575
Remainder of Grant Co.....	1,587,358	1,277,171	1,503,833	1,424,262	2,318,120	1,429,504	1,534,522	2,365,128
Iowa Co.....	1,231,408	1,097,382	1,209,109	1,059,986	1,625,498	1,508,733	1,222,280	1,672,157
Dodgeville....	153,886	111,122	99,026	96,449	163,818	113,860	198,406	247,110
Highland.....	110,074	86,308	92,715	117,435	131,896	121,558	156,170	157,542
Linden...	147,100	128,770	152,495	122,850	156,919	168,600	144,633	142,410
Mifflin.....	151,409	136,592	226,000	118,960	17,254	174,330	122,575	161,831
Mineral Point.	108,899	103,750	127,452	106,785	201,250	171,528	105,628	50,580
Ridgeway.....	112,710	133,990	166,940	134,726	244,101	205,816	129,841	230,727
Total.....	784,078	700,532	864,658	697,205	915,238	955,692	857,255	990,200
Remainder of Iowa Co.....	547,330	396,850	434,451	362,781	710,260	553,041	365,025	681,957
Lafayette Co....	1,736,233	1,670,684	1,707,952	1,377,106	1,826,476	1,060,683	762,484	1,682,067
Benton.....	107,318	109,330	127,470	27,910	97,207	94,950	40,260	81,975
New Diggings.	11,000	57,117	61,990	60,650	48,950	26,950	17,350	47,350
Shullsburg....	142,526	143,478	140,275	106,050	106,700	117,995	124,100	102,300
White Oak Sp.	31,911	69,300	47,782	37,264	46,906	43,200	27,820	62,720
Total.....	292,755	379,225	377,517	231,874	299,763	283,095	209,530	294,345
Remainder of Lafayette Co..	1,443,478	1,291,459	1,329,435	1,145,232	1,526,713	777,590	552,954	1,387,712

TABLE V.—*Pounds of butter, by towns, 1877-97.*

	1877.	1880.	1882.	1886.	1889.	1892.	1895.	1897.
Grant Co.....	684,142	930,757	1,111,080	1,254,338	1,502,478	982,720	1,209,968	1,584,139
Beetown.....	6,775	27,425	19,300	39,954	24,014	26,750	20,645	50,636
Clifton.....	20,283	23,390	30,000	28,325	47,900	43,600	40,410	58,100
Platteville....	42,425	34,245	25,725	21,135	36,700	2,975	406,075	66,000
Potosi.....	37,180	53,960	89,495	45,945	.....	35,900	57,380	76,910
Total.....	106,663	139,520	164,520	135,359	108,614	109,225	524,510	251,646
Remainder of Grant Co.....	577,479	791,237	946,560	1,118,979	1,392,864	873,495	685,458	1,332,493
Iowa Co.....	532,045	636,603	790,847	884,781	1,149,569	876,733	1,107,487	1,413,905
Dodgeville....	66,200	77,431	58,607	93,248	169,700	47,450	175,500	153,550
Highland.....	46,135	54,567	56,330	59,950	51,237	123,010	123,630	161,150
Linden.....	33,450	87,000	141,050	116,750	270,965	150,900	91,550	141,500
Mifflin.....	44,050	59,715	.....	40,400	74,500	32,275	33,563	60,225
Mineral Point.	44,787	92,985	107,850	128,950	98,212	64,763	155,241	52,901
Ridgeway.....	83,630	72,870	125,290	123,178	147,620	106,850	79,300	113,015
Total.....	324,252	464,068	489,127	562,476	812,234	525,248	659,086	682,341
Remainder of Iowa Co.....	207,793	222,545	301,720	322,305	337,335	351,485	448,401	731,564
Lafayette Co....	702,488	783,140	1,025,614	780,492	762,180	535,491	697,900	1,030,092
Benton.....	43,200	28,370	27,495	25,595	33,755	37,970	6,100	82,136
New Diggings.	18,000	23,100	65,469	31,780	32,200	26,800	.....	69,900
Shullsburg....	43,117	59,058	51,390	43,525	35,000	.....	6,000	40,600
White Oak Sp.	20,000	.....	32,300	34,937	24,900	....	34,250	39,350
Total.....	124,317	110,528	176,654	135,837	125,855	64,770	46,350	231,286
Remainder of Lafayette Co.	8,17175	672,612	848,960	644,655	636,325	460,721	651,550	808,806

TABLE VI.— *Valuation of farms and farm produce, 1885 and 1895.*

	1885.					1895.				
	Farm values.	Value of farm implements.	Value of agricultural produce.	Value of live stock.	Value of dairy produce.	Farm values.	Value of farm implements.	Value of agricultural produce.	Value of live stock.	Value of dairy produce.
Grant Co.	$13,076,535	$425,409	$2,391,910	$3,564,197	$334,648	$14,935,319	$393,247	$2,161,663	$2,913,644	$397,569
Beetown	$522,700	$20,560	$105,367	$161,108	$8,415	$20,587	$15,684	$31,845	$71,193	$1,738
Clifton	715,350	13,235	105,422	190,449	6,760	648,090	11,795	86,771	86,480	13,366
Platteville	854,309	20,705	89,656	193,431	64,029	710,094	16,563	126,211	140,929	16,067
Potosi	510,725	21,720	91,081	147,711	8,038	514,500	13,045	119,664	124,776	16,776
Total	$2,603,084	$76,240	$391,526	$692,699	$87,292	$1,893,271	$57,089	$364,491	$123,378	$47,947
Remainder of Grant Co.	$10,473,451	$349,169	$2,000,384	$2,871,498	$247,356	$13,042,048	$336,158	$2,097,172	$2,490,266	$349,622
Iowa Co.	$8,485,816	$283,683	$1,502,807	$2,455,540	$213,506	$10,118,192	$197,587	$1,481,346	$2,070,915	$410,652
Dodgeville	$939,195	$31,369	$172,791	$333,190	$17,746	$1,028,800	$21,351	$165,040	$192,970	$57,765
Highland	607,200	32,743	94,066	200,180	11,430	667,720	3,052	125,901	134,884	30,461
Linden	1,143,800	28,255	179,896	321,633	60,800	1,042,543	17,307	158,081	188,002	16,196
Mifflin	1,010,420	23,710	159,932	280,505	12,329	1,273,020	18,060	96,797	198,648	10,057
Mineral Point	968,339	22,290	137,432	276,574	19,462	970,865	12,880	136,820	210,623	62,574
Ridgeway	1,174,790	44,410	212,195	247,864	23,240	1,180,165	25,988	210,849	274,404	45,149
Total	$5,273,744	$182,777	$946,302	$1,659,947	$145,007	$6,163,113	$101,608	$892,488	$1,197,531	$222,237
Remainder of Iowa Co.	$2,612,072	$100,906	$556,505	$795,593	$68,499	$3,955,079	$95,979	$588,858	$873,384	$188,415
Lafayette Co.	$11,194,370	$303,932	$1,729,332	$2,834,541	$181,371	$12,848,146	$224,789	$1,754,976	$2,351,687	$121,325
Benton	$781,375	$11,200	$97,702	$171,263	$3,273	$590,744	$22,270	$114,459	$172,403	$32,456
New Diggings	553,126	14,690	70,484	160,399	7,042	580,000	8,215	70,451	93,209	22,156
Shullsburg	830,557	23,700	127,990	134,386	13,979	927,302	21,249	134,752	174,789	42,510
White Oak Springs	396,265	9,530	62,665	114,793	8,831	364,500	8,620	43,488	68,445	17,890
Total	$2,560,323	$59,120	$358,840	$580,841	$33,125	$2,462,546	$60,354	$363,150	$508,846	$115,012
Remainder of Lafayette Co.	$8,634,047	$244,812	$1,370,492	$2,253,700	$143,246	$10,385,600	$164,435	$1,391,826	$1,842,841	$306,313

APPENDIX B.

The sources for the tables in this appendix are as follows:

1. Farm products, 1878–97. Unbound original records in the vault of the office of the Secretary of State.

2. Valuations and products for 1860 and 1870. Bound original records as above.

3. Valuations and products for 1885 and 1895. Wisconsin census for the same years.

TABLE I.— *Population, 1860–95.*

Grant County towns.	1860	1865	1870	1875	1880	1885	1890	1895
Harrison	963	984	1,045	1,049	1,090	1,078	1,020	1,010
Hazel Green	2,542	2,686	2,161	2,121	1,821	1,764	1,549	1,453
Jamestown	1,402	1 362	1,114	1,194	1,215	1,149	961	1,002
Paris	682	771	907	940	876	903	778	832
Platteville	2,682	3,039	3,683	4,060	3,813	3,877	3,687	4,263
Potosi	2,734	2,754	2 686	2,644	2,375	2,147	2,110	2,061
Smelser	1,116	1,330	1,291	1,330	1,283	1,191	1,295	1,375
Lafayette Co. towns.								
Belmont	735	855	1,303	1,251	1,244	1,173	1,185	1,274
Benton	2,089	1,971	1,723	1,681	1,519	1,417	1,245	1,487
Center	1,917	2,692	.....	.....	.....	.....	.....	.....
Darlington	.....	.....	2,773	2,671	2,599	2,641	2,682	2,936
Elk Grove	1,316	1,405	1,377	933	959	868	788	802
Gratiot	1,006	1,323	1,718	1,721	1,634	1,489	1,511	1,558
Kendall	1,132	978	1,131	888	849	792	754	705
Monticello	459	473	480	469	413	325	305	311
New Diggings	1,689	1,726	1,794	1,805	1,641	1,482	1,374	1,325
Seymour	.....	.....	479	938	898	839	783	803
Shullsburg	2,491	2,718	2,702	2,540	2,245	2,197	2,270	2,155
White Oak Springs	513	523	540	446	451	449	384	433
Willow Springs	843	950	1,117	1,064	1,089	1,041	931	989

TABLE II.

1878.

	Bushels of wheat.	Bushels of corn.	Bushels of oats.	Tons of cultivated grass	Pounds of butter.	Pounds of cheese.	Bushels of barley.	Bushels of rye.	Bushels of potatoes.
Grant Co.....	316,553	2,710,760	1,655,138	4,945	725,257	87,295	24,875	63,642	179,947
Harrison.....	4,650	60,580	35,450	10	31,885	10,800	120	1,953	8,727
Hazel Green.....	7,262	222,070	147,450	2,400	70,000	0	3,400	350	10,000
Jamestown.....	12,705	73,330	74,060	0	20,545	0	1,580	1,808	15,310
Paris.....	8,048	2,039	29,690	0	10,460	0	374	739	8,973
Platteville..... ...	6,535	157,069	105,798	0	34,510	3,700	1,102	1,520	15,548
Potosi.....	14,494	164,370	72,412	14	35,228	0	626	4,152	14,878
Smelser	5,620	214,475	116,822	0	29,115	0	2,479	1,555	6,104
Lafayette Co.....	63,018	2,021,031	2,056,009	17,440	723,159	63,520	11,469	30,835	89,476
Belmont.....	5,138	141,300	120,720	27	24,660	0	1,340	1,560	5,095
Benton.....	3,812	149,825	91,630	2,270	23,075	0	0	370	3,790
Darlington.....	4,644	76,400	70,700	28	23,650	9,500	358	1,547	5,031
Elk Grove.....	2,821	173,965	727,300	2,500	19,410	0	125	320	5,476
Gratiot..... ...	5,116	229,737	192,740	300	95,900	0	3,350	5,704	9,065
Kendall.....	6,820	82,021	74,629	750	40,100	0	1,060	1,344	9,225
Monticello.....	0	104,350	78,993	1,000	19,805	10,600	270	120	2,602
New Diggings.....	6,119	65,140	50,473	1,674	8,625	0	342	120	2,193
Seymour	3,925	188,955	141,935	400	53,643	3,600	940	520	6,037
Shullsburg.....	1,171	172,710	98,624	705	37,110	0	0	240	5,664
White Oak Sps....	397	84,900	12,270	40	18,600	8,000	0	0	1,125
Willow Springs...	4,535	96,400	40,490	850	20,410	0	400	598	6,288

TABLE III.

1880.

	Bushels of wheat.	Bushels of corn.	Bushels of oats.	Tons of cultivated grass.	Pounds of butter.	Pounds of cheese.	Bushels of barley.	Bushels of rye.	Bushels of potatoes.
Grant Co.....	225,574	2,520,998	1,598,021	46,425	930,757	95,322	42,639	37,130	223,633
Harrison.....	5,272	13,960	37,465	1,117	34,560	17,700	94	1,177	11,605
Hazel Green.....	6,797	205,800	154,886	1,936	75,550	0	3,388	85	15,340
Jamestown.....	11,422	47,884	56,607	908	17,110	0	5,162	529	12,267
Paris.....	11,422	47,844	56,607	908	17,110	0	5,162	529	12,267
Platteville	4,812	147,780	99,270	1,913	34,245	5,122	3,400	1,922	11,025
Smelser.....	6,214	181,250	125,948	1,306	53,350	0	5,658	649	10,031
Lafayette Co.....	212,537	2,000,345	1,670,684	26,372	783,140	29,900	26,311	11,552	109,283
Belmont.....	6,490	146,800	122,660	1,490	31,900	0	3,895	1,260	7,085
Benton.....	2,623	156,190	109,330	1,648	28,370	0	280	230	5,765
Darlington.....	6,483	136,700	107,549	5,325	72,875	3,300	2,804	237	7,278
Elk Grove.....	2,455	181,800	121,200	722	29,150	0	1,450	380	7,500
Gratiot.....	22,342	209,550	154,508	2,113	81,540	0	8,414	1,049	7,742
Kendall.....	6,343	84,585	78,412	144	36,454	0	4,239	776	10,863
Monticello.....	1,320	97,400	88,100	1,400	20,450	19,900	0	135	1,975
New Diggings.....	5,852	69,360	57,117	200	23,100	0	554	237	2,808
Seymour	7,295	141,900	143,550	1,620	61,200	5,000	800	480	9,090
Shullsburg	3,214	173,900	143,478	1,670	59,058	500	0	225	6,490
White Oak Sps....	1,700	100,800	69,300	0	0	0	0	0	.....
Willow Springs...	13,972	52,880	52,649	1,156	25,000	0	330	244	5,455

TABLE IV.

1884.

	Bushels of wheat.	Bushels of corn.	Bushels of oats.	Tons of cultivated grass.	Pounds of butter.	Pounds of cheese.	Bushels of barley.	Bushels of rye.	Bushels of potatoes.
Grant Co.....	232,738	2,246,321	2,127,974	71,598	1,281,005	121,340	55,923	77,285	308,779
Harrison.....	6,663	19,773	32,191	1,827	29,914	16,560	420	3,627	10,061
Hazel Green..	4,606	122,600	114,360	2,971	36,965	0	3,054	354	8,405
Jamestown....	11,951	88,170	89,127	2,253	36,895	0	4,897	1,228	21 295
Paris.....	8,650	49,641	61,226	1,358	23,105	0	3,327	1,946	10,832
Platteville....	8,812	103,105	105,750	2,996	25,005	2,000	4,222	5,391	8,156
Potosi.....	11,536	121,545	107,018	2,525	50,245	0	2,046	4,868	18,580
Smelser	4,115	179,950	153,365	3,311	73,875	0	3,365	4,663	8,997
Lafayette Co....	69,075	1,591,590	1,661,479	49,234	1,153,954	123,700	71,507	17,749	119,538
Belmont.....	4,347	111,130	153,320	2,758	40,619	0	6,179	3,539	6,173
Benton.....	1,100	130,520	105,950	2,208	26,575	0	400	185	5,285
Darlington....	6,957	110,550	88,650	5,000	280,000	450	14,350	703	8,747
Elk Grove.....	2,720	136,000	135,700	3,385	27,800	0	3,285	2,700	5,080
Gratiot.....	7,082	158,580	158,770	4,460	99,382	0	12,440	1,741	9,507
Kendall.....	5,120	92,775	104,457	2,396	39,430	0	10,843	2,059	10,407
Monticello....	827	52,600	60,120	2,595	42,400	0	675	0	1,760
New Diggings.	5,336	88,330	71,669	2,206	37,746	50	2,552	243	3,869
Seymour	4,785	138,500	122,715	2,516	69,745	0	8,640	275	8,315
Shullsburg....	1,675	134,480	114,650	3,274	55,580	0	3,810	100	8,115
White Oak Sps	751	73,000	46,275	2,265	45,725	1,200	70	75	2,922
Willow Sps....	5,035	110,690	111,517	2,821	70,546	0	3,913	215	9,304

TABLE V.

1886.

	Bushels of wheat.	Bushels of corn.	Bushels of oats.	Tons of cultivated grass.	Pounds of butter.	Pounds of cheese.	Bushels of barley.	Bushels of rye.	Bushels of potatoes.
Grant Co.....	169,840	1,378,618	1,743,239	106,861	1,254,338	167,355	91,578	41,163	140,960
Harrison.....	5,093	30,655	81,204	2,084	40,950	9,300	670	2,769	4,941
Hazel Green..	4,520	126,675	149,822	3,702	43,162	0	4,128	235	8,727
Jamestown....	7,212	54,535	94,989	2,405	29,360	0	2,891	225	14,291
Paris.....	5,570	28,400	60,001	1,739	21,596	0	1,465	603	6,340
Platteville....	4,900	20,293	74,688	18,981	21,135	0	6,280	3,290	4,797
Potosi.....	7,915	67,670	89,815	2,296	45,945	0	1,530	2,304	9,971
Smelser.....	2,168	89,860	114,045	3,354	47,260	0	5,296	1,865	5,005
Lafayette Co....	49,487	887,697	1,377,106	53,847	780,492	155,635	103,240	14,805	65,693
Belmont.....	2,906	113,360	148,010	2,767	34,550	0	3,424	2,976	4,760
Benton..... ..	1,861	45,205	72,910	1,828	25,595	0	1,363	0	2,196
Darlington....	3,372	24,166	95,112	3,910	3,316	320	2,874	1,150	2,560
Elk Grove.....	1,414	50,000	81,600	2,815	20,600	0	5,510	1,160	2,235
Gratiot.....	6,630	85,020	181,825	5,936	115,500	0	21,845	1,015	5,382
Kendall.....	3,306	22,070	68,425	2,076	34,515	0	6,067	615	3,305
Monticello. ..	847	38,450	55,245	2,229	21,700	300	4,241	0	1,364
New Diggings.	3,205	38,096	60,650	2,600	31,780	0	3,827	614	2,231
Seymour	4,667	62,639	126,195	3,225	50,275	0	15,010	75	4,474
Shullsburg....	1,397	74,960	106,050	4,821	43,525	0	12,490	100	3,615
White Oak Sps	359	41,280	87,264	2,057	34,937	0	1,745	0	1,876
Willow Sps....	2,882	63,015	80,118	3,168	61,625	0	8,067	355	5,701

TABLE VI.

1889.

	Bushels of wheat.	Bushels of corn.	Bushels of oats.	Tons of cultivated grass.	Pounds of butter.	Pounds of cheese.	Bushels of barley.	Bushels of rye.	Bushels of potatoes.
Grant Co.....	131,172	2,394,122	2,760,346	73,783	1,502,478	262,825	42,459	93,501	266,749
Harrison.....	2,270	31,000	37,160	1,643	18,140	31,982	0	2,919	6,750
Hazel Green..	1,967	167,950	181,890	3,872	93,700	0	9,350	1,230	16,810
Jamestown....	4,168	91,350	108,741	2,075	34,180	0	4,100	2,083	27,550
Paris.....	3,894	69,195	75,541	1,868	32,614	0	2,560	1,958	14,375
Platteville....	3,360	102,325	137,835	3,563	36,700	7,500	1,540	5,910	8,450
Potosi.....	5,560	107,940	114,096	3,240	0	0	1,475	3,530	12,930
Smelser.....	368	81,800	112,400	2,598	27,800	0	800	2,102	7,240
Lafayette Co....	27,626	1,624,853	1,826,476	45,060	762,180	512,100	48,127	31,335	108,548
Belmont.....	2,079	129,050	196,500	4,019	47,650	0	960	2,995	0
Benton.....	839	100,920	97,007	2,244	33,755	0	2,875	747	6,804
Darlington,...	1,508	62,450	90,686	2,170	35,700	0	1,255	5,416	5,490
Elk Grove....	690	133,900	151,050	2,798	37,900	0	2,315	3,125	9,145
Gratiot.....	3,951	166,465	203,024	4,362	94,425	0	13,044	3,194	10,500
Kendall	2,629	80,606	131,071	1,950	44,050	0	2,070	2,995	8,895
Monticello....	816	71,200	83,754	2,068	30,110	0	1,457	375	2,878
New Diggings.	1,790	47,950	48,950	1,424	32,200	0	4,158	126	2,680
Seymour.....	2,730	123,550	197,850	3,166	87,120	0	5,830	440	2,600
Shullsburg....	625	94,500	106,700	2,035	35,000	0	5,660	0	4,575
White Oak Sps	936	59,900	46,906	1,698	24,900	0	2,175	90	2,469
Willow Sps....	1,356	193,595	127,851	3,705	35,625	2,000	761	1,839	5,081

TABLE VII.

1892.

	Bushels of wheat.	Bushels of corn.	Bushels of oats.	Tons of cultivated grass.	Pounds of butter.	Pounds of cheese.	Bushels of barley.	Bushels of rye.	Bushels of potatoes.
Grant Co.....	122,631	1,615,089	1,807,209	59,771	942,730	568,294	24,979	64,886	145,610
Harrison.....	545	6,610	8,480	274	6,950	5,300	0	1,048	635
Hazel Green..	398	141,373	138,610	3,896	50,660	0	2,574	943	11,225
Jamestown....	1,464	66,025	94,805	2,995	34,655	0	1,278	1,138	15,330
Paris.....	7,474	38,800	50,429	1,836	24,225	40,000	287	743	8,131
Platteville....	4,370	103,155	115,745	3,768	2,975	15,000	60	4,601	5,395
Potosi.....	3,635	64,075	84,015	2,080	35,900	0	920	3,345	7,285
Smelser.....	75	194,940	136,765	2,574	39,220	0	600	585	6,325
Lafayette Co....	14,255	1,010,258	1,060,685	37,731	535,491	1,183,031	7,297	15,528	46,704
Belmont.....	1,541	61,009	84,997	0	30,320	7,850	60	1,040	2,870
Benton.....	530	95,725	94,950	3,242	37,970	112,300	1,005	525	4,117
Darlington....	955	39,600	38,700	0	24,600	0	920	1,265	1,635
Elk Grove.....	70	106,675	12,750	2,616	45,000	0	0	340	3,809
Gratiot.....	1,575	147,610	13,650	3,646	84,200	0	1,550	1,785	5,063
Kendall.....	300	14,800	33,100	1,400	20,000	20,000	0	60	834
Monticello....	170	43,660	72,395	1,521	25,235	0	38	130	877
New Diggings.	450	35,300	26,950	682	26,800	0	0	240	416
Seymour.....	0	10,950	124,150	2,790	69,700	0	0	0	3,725
Shullsburg....	0	112,150	117,995	3,380	0	0	1,520	0	3,677
White Oak Spa	50	26,500	43,200	1,208	0	0	700	100	611
Willow Spa....	245	36,360	54,350	3,503	32,975	73,040	0	1,610	0

TABLE VIII.

1895.

	Bushels of wheat.	Bushels of corn.	Bushels of oats.	Tons of cultivated grass.	Pounds of butter.	Pounds of cheese.	Bushels of barley.	Bushels of rye.	Bushels of potatoes.
Grant Co.....	47,492	1,153,252	1,777,042	11,324	1,209,968	562,063	7,178	179,023	197,404
Harrison.....	144	9,200	6,440	0	3,200	0	0	2,880	1,880
Hazel Green...	68	70,750	243,180	50	55,100	0	160	2,310	12,214
Jamestown....	293	60,900	58,290	9	43,090	0	430	1,700	33,640
Paris.....	77	58,150	31,340	61	25,850	32,556	0	2,084	14,285
Platteville....	435	59,425	80,655	270	406,075	0	20	2,830	7,238
Potosi.....	596	86,375	62,635	69	59,380	0	0	8,190	16,415
Smelser	0	61,255	83,456	87	74,600	0	220	1,255	9,430
Lafayette Co....	1,334	785,304	762,484	5,430	697,900	1,331,250	415	25,397	53,624
Belmont.....	335	90,420	107,410	300	49,960	2,000	50	2,532	4,761
Benton.....	0	37,415	40,260	27	6,100	0	0	615	3,003
Darlington....	200	10,000	25,000	600	15,200	4,000	200	300	200
Elk Grove.....	0	84,065	65,120	0	44,100	350	0	580	4,175
Gratiot.....	0	93,263	84,133	163	123,300	0	50	3,028	5,027
Kendall.....	0	22,156	26,968	910	0	0	0	3,285	2,406
Monticello....	0	34,700	36,525	63	41,275	0	0	602	1,204
New Diggings.	0	26,100	17,350	0	0	0	0	0	1,767
Seymour	0	58,150	62,115	156	28,650	14,300	0	180	4,305
Shullsburg....	0	137,500	124,100	2,112	6,000	0	1,800	132	3,589
White Oak Sps	0	26,580	27,820	0	34,250	0	0	0	1,018
Willow Sps....	0	52,331	92,191	2,325	5,540	120,600	0	3,061	2,510

TABLE IX.

1897.

	Bushels of wheat.	Bushels of corn.	Bushels of oats.	Tons of cultivated grass.	Pounds of butter.	Pounds of cheese.	Bushels of barley.	Bushels of rye.	Bushels of potatoes.
Grant Co.....	49,713	2,763,061	2,555,989	52,309	1,450,451	799,313	56,398	223,120	217,565
Harrison.....	540	29,110	21,110	692	27,150	0	150	2,855	1,577
Hazel Green..	80	196,400	142,662	3,198	78,500	0	1,785	7,069	21,510
Jamestown....	441	110,450	86,013	1,103	57,915	0	567	5,985	49,885
Paris.....	204	99,980	58,454	1,553	23,590	27,250	300	3,137	11,315
Platteville....	450	113,500	117,000	2,285	115,000	0	2,200	13,060	5,950
Potosi.....	222	109,360	87,975	2,096	65,550	0	230	10,704	9,360
Smelser.....	0	169,780	136,905	2,520	93,226	0	1,008	6,098	12,408
Lafayette Co....	2,451	1,641,351	1,648,709	42,205	1,019,605	1,643,219	9,520	39,810	52,292
Belmont.....	75	122,100	143,700	2,335	58,000	0	400	7,290	4,043
Benton.....	140	126,150	85,695	2,374	62,350	0	280	1,195	4,554
Darlington....	0	95,500	80,300	1,811	71,410	0	0	85	1,848
Elk Grove.....	0	146,500	127,100	2,360	63,500	0	0	1,903	3,475
Gratiot.....	22	182,960	164,135	3,561	71,870	123,679	2,220	3,455	4,471
Kendall.....	0	47,820	103,490	1,353	6,870	12,000	20	895	2,516
Monticello....	0	87,400	83,300	1,509	29,300	2,000	1,100	753	1,494
New Diggings.	400	82,350	58,915	1,448	151,600	0	245	300	3,320
Seymour.....	125	198,200	176,200	1,800	82,300	80,100	910	1,170	3,360
Shullsburg....	0	137,500	124,100	2,112	6,000	0	1,800	133	3,589
White Oak Spg	175	15,000	12,000	1,000	20,000	5,000	800	0	100
Willow Spg....	0	70,911	119,640	5,560	7,290	150,190	0	4,090	4,000

TABLE X.

1860.

	Farm value.	Value of farm implements.	Value of live stock.	Bushels of wheat.	Bushels of corn.	Bushels of oats.
Grant Co.	$5,001,359	$284,991	$374,383	670,422	871,845	710,367
Harrison	$121,880	$7,493	$23,557	4,488	14,068	8,024
Hazel Green	374,665	15,990	52,140	29,163	84,201	73,646
Jamestown	174,320	9,508	28,908	13,720	34,085	22,831
Paris	70,390	5,029	16,043	5,782	11,627	7,221
Platteville	387,530	21,534	52,177	27,327	34,085	69,009
Potosi	163,130	12,551	34,939	13,307	23,311	17,359
Smelser	291,690	16,426	46,598	34,836	48,153	66,491
Lafayette Co.	$2,285.622	$163,163	$404,093	319,950	347,846	516,990
Belmont	$217,340	$17,386	$36,001	31,752	35,831	68,844
Benton	145,855	12,371	33,643	28,811	19,490	39,579
Center	193,255	28,788	31,228	52,801	39,025	52,965
Darlington	.....	.....	.....	.....	.....	.....
Elk Grove	320,133	25,607	54,221	49,444	45,811	107,643
Gratiot	247,350	14,289	42,295	45,985	53,140	53,590
Kendall	250,121	21,163	46,004	36,212	37,580	50,468
Monticello	200,158	9,254	30,833	18,996	25,085	42,206
New Diggings	162,520	8,255	26,138	9,115	15,745	15,718
Seymour	.....	.....	.....	.....	.....	.....
Shullsburg	181,635	10,940	44,551	22,834	29,294	36,153
White Oak Springs	159,555	5,895	25,779	7,561	18,670	19,401
Willow Springs	207,700	9,235	33,400	16,449	28,175	30,318

TABLE XI.

1870.

	Farm value.	Value of farm implements.	Value of live stock.	Bushels of wheat.	Bushels of corn.	Bushels of oats.
Grant Co.	$11,662,855	$674,760	$3,053,186	914,455	1,744,398	1,433,020
Harrison	208,509	15,141	67,187	12,154	55,725	31,575
Hazel Green	1,055,565	35,948	139,890	32,474	128,098	150,101
Jamestown	429,720	15,152	58,675	25,988	59,530	58,794
Paris	352,490	16,086	43,693	26,566	51,495	42,788
Platteville	535,860	24,695	87,039	22,891	80,175	100,831
Potosi	343,405	19,804	88,376	21,451	78,364	49,431
Smelser	795,850	39,575	119,843	36,801	135,985	143,893
Lafayette Co.	$7,897,893	$317,480	$1,265,630	368,166	1,052,993	1,200,608
Belmont	$868,800	$33,503	$104,069	23,562	93,490	113,043
Benton	703,310	22,475	103,715	18,066	96,860	102,400
Darlington	209,675	28,925	121,973	44,192	108,050	100,015
Elk Grove	1,247,750	51,885	156,477	43,215	170,405	195,928
Gratiot	995,713	40,285	15,788	65,728	135,690	176,817
Kendall	1,008,510	33,620	138,715	41,591	108,800	103,718
Monticello	399,890	15,350	66,521	10,935	65,850	94,510
New Diggings	608,180	17,505	91,241	23,208	62,795	54,260
Seymour	375,604	12,955	48,429	22,690	42,900	60,231
Shullsburg	516,236	26,967	134,927	38,047	87,965	108,062
White Oak Springs	285,625	9,840	63,197	9,458	33,285	34,660
Willow Springs	683,600	24,170	85,578	27,546	56,913	56,776

TABLE XII.

1885.

	Farm value.	Value of farm implements.	Value of live stock.	Bushels of wheat.	Bushels of corn.	Bushels of oats.
Grant Co.	$13,076,935	$425,409	$3,564,099	259,397	2,710,607	2,374,807
Harrison	$375,525	$19,980	$110,220	7,926	77,070	43,780
Hazel Green	1,124,151	39,510	244,312	5,216	209,615	188,210
Jamestown	694,383	18,866	124,349	12,686	96,197	103,540
Paris	269,856	11,759	74,516	9,707	63,580	71,718
Platteville	854,309	20,705	193,341	9,788	110,662	113,772
Potosi	510,725	21,720	147,711	11,158	125,065	101,797
Smelser	758,365	8,909	59,247	4,367	182,825	167,975
Lafayette Co.	$8,405,993	$223,087	$1,954,803	54,568	1,633,403	1,514,380
Belmont	$737,200	$33,300	$206,405	5,445	155,600	206,160
Benton	781,375	11,200	14,415	1,904	159,756	127,920
Darlington	861,008	22,280	163,878	7,728	130,841	96,927
Elk Grove	736,785	20,295	213,516	3,469	177,220	154,677
Gratiot	1,119,400	30,350	338,030	9,198	202,295	191,339
Kendall	637,899	15,667	197,329	6,571	110,490	120,981
Monticello	414,100	10,380	71,518	891	62,380	66,100
New Diggings	553,126	14,690	160,899	6,212	108,336	81,240
Seymour	921,900	23,350	235,577	5,236	178,595	172,435
Shullsburg	830,557	23,700	134,386	2,016	158,340	130,155
White Oak Springs	395,265	9,530	114,793	785	78,220	54,985
Willow Springs	417,378	18,345	104,057	5,113	111,330	111,570

TABLE XIII.

1895.

	Farm value.	Value of farm implements.	Value of live stock.	Bushels of wheat.	Bushels of corn.	Bushels of oats.
Grant Co.	$14,935,319	$393,247	$2,913,644	102,760	1,414,037	3,030,425
Harrison	389,650	15,031	83,427	3,363	44,337	80,719
Hazel Green	1,130,712	18,717	185,209	424	143,925	146,242
Jamestown	654,050	9,480	81,523	582	60,435	104,522
Paris	407,320	12,209	68,387	597	54,589	95,261
Platteville	710,094	16,565	138,829	2,915	71,515	131,470
Potosi	514,500	13,045	124,453	2,293	86,050	127,559
Smelser	981,456	23,932	149,746	.....	122,720	145,270
Lafayette Co.....	$9,269,547	$170,246	$1,663,617	2,175	1,202,890	1,488,969
Belmont	$864,865	$19,590	$135,081	1,255	68,840	121,289
Benton	590,744	22,270	137,317	80	118,630	87,045
Darlington	872,890	18,979	158,655	40	106,960	143,152
Elk Grove	685,061	12,795	157,800	.....	105,660	148,490
Gratiot	1,404,620	24,866	296,754	190	198,295	281,089
Kendall	609,739	.....	76,053	360	33,240	97,409
Monticello	558,175	7,055	96,585	140	190,770	37,068
New Diggings	580,000	8,215	93,209	90	65,935	79,189
Seymour	1,077,446	14,410	163,174	.....	132,895	158,296
Shullsburg	927,302	21,249	157,415	.....	145,195	137,525
White Oak Spring	364,500	8,620	68,445	.....	73,710	71,190
Willow Springs ...	734,205	12,197	123,129	50	57,770	117,245

APPENDIX C.

DIVISIONS OF JO DAVIESS COUNTY.

Jo Daviess County, before the year 1853, was divided, for administrative purposes, into a number of precincts. These precincts varied from time to time in extent, and the name was frequently changed. The precincts also varied in number. These facts are all that remain today concerning the old county subdivisions. There is no record available, and the memory of the oldest inhabitants does not serve to recall the facts concerning them. The boundaries of the precincts seem to have been little understood even by the people of that time, for the census enumerator in 1850 says the indefiniteness of the boundaries greatly delayed the completion of his work.[1]

The new system of township organization was adopted February 15, 1853.[2] The divisions and names, as selected at that time, are shown on Map 1, Plate XXII. The divisions of this map, as well as of Maps 2 and 3, are laid off exactly as described in the proceedings of the county board of supervisors.

Map 1 shows comparatively few differences from the map of the present day. Menominee included Dunleith, and was bounded on the east by the Sinsinnewa River. Vinegar Hill was called Mann. Scales included the present townships of Council Hill and Scales Mound. West Galena included Rawlins, East Galena included Rice, Thompson included Apple River, and Pleasant Valley, Berreman. Courtland was the name given at first to Warren township, and it preserved this name until 1865.

The boundaries, as established in 1853, were not entirely satisfactory, and the county board made some changes in the period between 1854 and 1865, as shown in Map 2. The township of Scales was divided into the two townships of Council Hill and Scales Mound in June, 1854.

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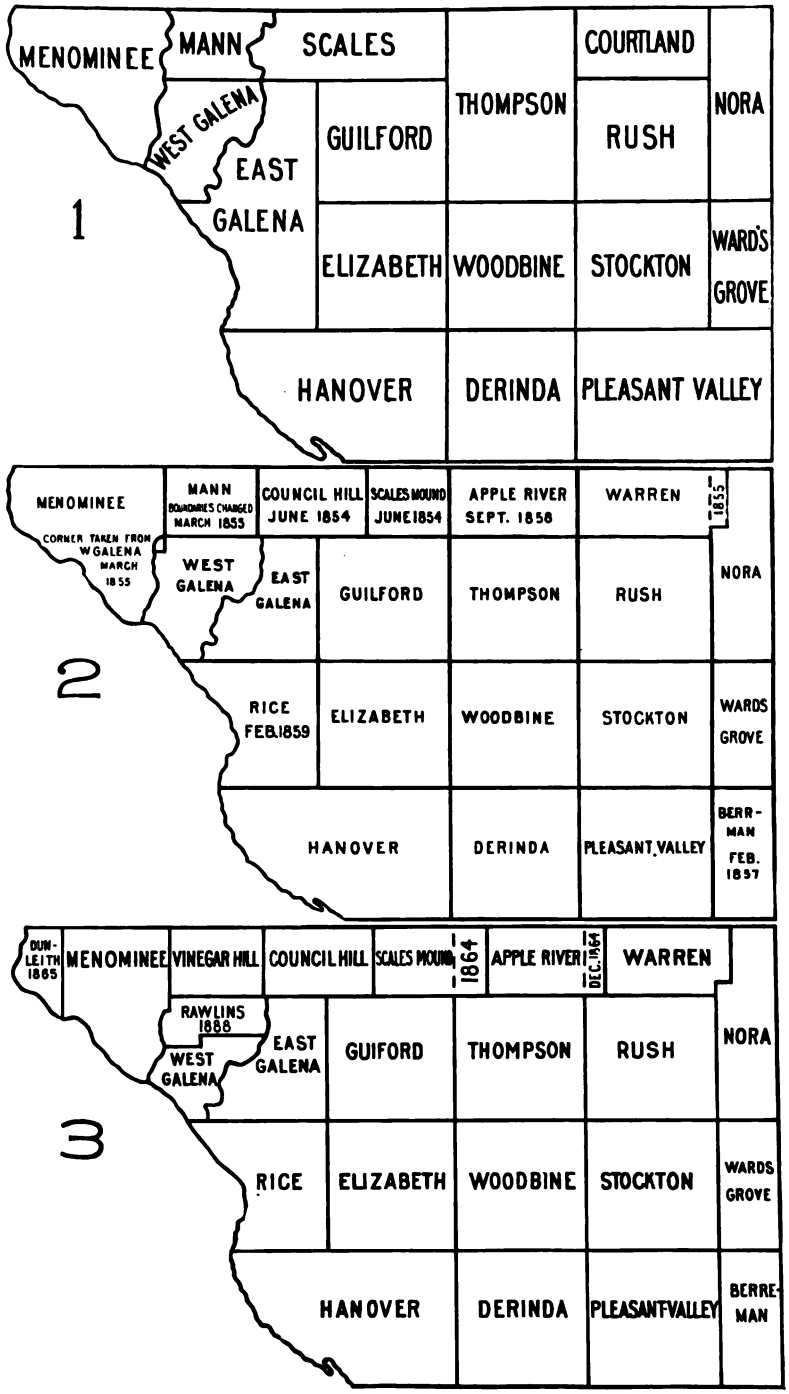
[1] Northwestern Gazette and Galena Advertiser, Dec. 21, 1850.

[2] History of Jo Daviess County, p. 350.


1
MENOMINEE
MANN
SCALES
COURTLAND
WEST GALENA
EAST GALENA
GUILFORD
THOMPSON
RUSH
NORA
ELIZABETH
WOODBINE
STOCKTON
WARD'S GROVE
HANOVER
DERINDA
PLEASANT VALLEY
2
MENOMINEE
CORNER TAKEN FROM W GALENA MARCH 1855
MANN BOUNDARIES CHANGED MARCH 1855
COUNCIL HILL JUNE 1854
SCALES MOUND JUNE 1854
APPLE RIVER SEPT. 1858
WARREN
1855
WEST GALENA
EAST GALENA
GUILFORD
THOMPSON
RUSH
NORA
RICE FEB. 1859
ELIZABETH
WOODBINE
STOCKTON
WARDS GROVE
HANOVER
DERINDA
PLEASANT VALLEY
BERR-MAN FEB. 1897
3
DUN-LEITH 1885
MENOMINEE
VINEGAR HILL
COUNCIL HILL
SCALES MOUND
1864
APPLE RIVER
DEC. 1864
WARREN
RAWLINS 1888
WEST GALENA
EAST GALENA
GUIFORD
THOMPSON
RUSH
NORA
RICE
ELIZABETH
WOODBINE
STOCKTON
WARDS GROVE
HANOVER
DERINDA
PLEASANT VALLEY
BERRE-MAN

In March, 1855, the eastern and western boundaries of Mann township were changed from the rivers and run along section lines. The eastern boundary was run from the S. E. corner of section 33, township 29, range 1 east, northward to the state line. The western boundary was run from the state line southward from the N. W. corner of section 15, township 29, range 1 west, to the S. W. corner of section 34, township 29, range 1 west.[1]

The northwest corner of Nora township was added to Courtland township March 15, 1855, so that the village of Warren would be in a township by itself, and not be obliged to share with Nora in the election of supervisors.

In February, 1857, the township of Berreman was created from Pleasant Valley. In September, 1858, Apple River was set off from Thompson, and in February, 1859, Rice was set off from East Galena.

Map 3 shows the remaining changes in the boundaries. December 14, 1864, the west end of Warren township was added to Apple River, and the west end of Apple River was added to Scales Mound, thus throwing the villages of those names into their corresponding townships. In March, 1865, Dunleith township was set off from Menominee, and in 1888 Rawlins township was created from West Galena; since that date the boundaries have remained unchanged.

[1] History of Jo Daviess County, p. 355.

TABLE I.—*Area and population of the towns in Jo Daviess County, 1840–90.*

Towns.	Area square miles.	Population from United States Census.						
		1840.	1860.	1870.			1880.	1890.
				Total.	Native born.	Foreign born.		
Apple River	19.7	.....	508	1,108	804	304	1,035	950
Berreman	18.0	.....	415	559	494	65	590	561
Council Hill	16.4	187	850	725	470	255	595	429
Derinda	36.5	.....	818	804	501	303	944	743
East Galena	21.8	170	1,045	856	520	336	867	782
Elizabeth	36.0	.....	1,460	1,618	1,163	455	1,385	1,258
Galena City	3.8	1,843	8,196	7,019	4,546	2,473	6,451	5,635
Guilford	36.4	.....	1,093	1,079	752	327	1,080	933
Hanover	51.2	.....	969	1,191	960	231	1,410	1,666
Menominee / Dunleith	37.5	169	1,710	1,945	1,314	631	2,011	2,036
Nora	24.4	.....	950	1,046	918	128	1,007	851
Pleasant Valley	36.5	310	767	943	764	179	923	859
Rice	26.8	.....	539	570	382	188	676	498
Rush	36.5	.....	951	1,036	867	169	1,106	1,067
Scales Mound	12.8	343	896	748	489	259	808	696
Stockton	35.8	.....	1,044	1,214	1,027	187	1,208	1,352
Thompson	36.3	.....	647	800	522	278	948	955
Vinegar Hill	13.7	124	872	693	432	261	649	507
Ward's Grove	17.6	.....	425	530	474	56	403	404
Warren	21.7	.....	1,634	1,786	1,533	253	1,897	1,587
West Galena / Rawlins	17.3	434	601	591	374	217	531	440
Woodbine	35.9	.....	935	959	660	299	1,004	897

NOTE.—The above figures for population were all taken from U. S. Census Reports. In addition to the figures for 1840 given in the table, there were precincts at that time having the following population: Apple River (which included Elizabeth and Weston), 550; East Fork, 527; Imus, 401; McDonald's, 483; Plum River, 345; Small Pox, 351.

The census report for 1850 does not give the population of Jo Daviess by county subdivisions and it is omitted from the table for that reason.

TABLE II.—***Population and occupation for the towns in Jo Daviess County, 1840.***

	Free Whites.		Free colored.	Slaves.	Miners.	Farmers.	Merchants.	Manufacturers.	River navigators.	Professional men and engineers.	No. of white illiterates over 20.
	Male.	Female.									
Galena	993	722	126	2	69	167	101	169	4	27	90
Apple River	328	220	2	.....	21	117	.....	28	.....	1	29
Council Hill	126	61	.....	.....	71	10	.....	1	.....	1	14
East Fork	332	195	.....	.....	150	41	.....	4	.....	1	39
East Galena	108	62	.....	.....	38	20	.....	2	.....	.....	13
Imus	234	167	.....	.....	20	77	1	5	.....	1	14
McDonald	295	188	.....	.....	95	54	4	7	.....	2	35
Menominee	102	67	.....	.....	11	35	.....	.....	.....	.....	19
Pleasant Grove	106	204	.....	.....	5	37	.....	3	.....	.....	17
Plum River	207	138	.....	4	11	70	.....	12	.....	1	26
Scales	206	137	.....	.....	17	67	.....	10	.....	.....	43
Small Pox	209	139	3	.....	14	69	.....	8	.....	1	14
Vinegar Hill	79	45	.....	.....	66	18	.....	1	.....	.....	11
West Galena	259	172	3	.....	29	94	1	13	2	1	35
	.....	.....	134	6	617	876	107	268	6	36	399

NOTE.—This table is taken from the Census Report for 1840.

TABLE III.—*Valuation of real estate and personal property for the towns in Jo Daviess County, 1853–75.*

	1853.		1857.		1860.	
	Real property.	Personal property.	Real property.	Personal property.	Real property.	Personal property.
Apple River	.....	.....	.....	....	$95,784	$30,860
Berreman	.....	.....	$36,672	$17,202	30,612	27,538
Council Hill	.....	.....	74,930	29,571	52,457	12,709
Derinda	$42,005	$24,335	89,554	49,528	79,758	27,306
Dunleith	.....	.....	.....	.....	.....	.....
East Galena	387,271	51,294	462,005	72,792	200,654	21,497
Elizabeth	92,858	56,148	146,757	70,842	133,047	42,307
Guilford	72,656	30,601	109,751	46,284	85,895	30,293
Hanover	110,420	38,404	180,167	78,004	127,000	50,857
Menominee	56,399	10,459	204,539	21,124	152,796	10,477
Nora	61,974	25,170	124,107	38,175	97,935	27,282
Pleasant Valley	35,248	22,914	70,740	31,701	55,770	16,257
Rice	.....	.....	.....	.....	72,531	8,350
Rush	57,303	23,258	124,997	43,795	106,346	19,561
Scales Mound	81,645	54,652	62,800	31,732	53,382	21,571
Stockton	37,799	30,055	111,991	52,478	73,284	26,572
Thompson	15,839	26,342	158,386	48,255	57,291	16,139
Vinegar Hill	65,560	11,004	79,803	18,176	52,857	10,408
Ward's Grove	.....	.....	54,153	24,485	55,381	14,570
Warren	36,383	18,219	112,774	48,779	126,346	53,048
West Galena	1,848,967	662,988	1,786,851	603,357	830,810	281,635
Woodbine	65,950	30,199	89,865	35,422	78,724	19,521

TABLE III.—Continued.

	1865.		1870.		1875.		
	Real property.	Personal property.	Real property.	Personal property.	Real property.	Personal property.	Town lots.
Apple River.....	$62,859	$21,864	$97,003	$35,487	$135,690	$51,377	$36,645
Berreman..... ...	28,399	9,184	29,460	24,652	67,229	23,908	.....
Council Hill.....	40,792	11,867	53,439	20,998	107,273	26,357	1,773
Derinda.....	62,355	21,738	79,806	48,234	158,396	58,450	.....
Dunleith..	.....	.....	49,043	86,053	168,733	23,830	33,234
East Galena.....	104,952	23,609	116,355	32,153	151,947	56,719	37,738
Elizabeth	95,641	82,887	131,295	62,990	217,622	135,711	28,458
Guilford.....	71,551	19,428	86,700	34,860	163,296	46,460	.....
Hanover.....	105,062	26,193	110,314	54,701	203,020	83,337	14,395
Menominee.....	42,775	9,143	58,612	16,110	113,008	25,489	.....
Nora	69,911	30,334	105,863	48,844	224,223	67,322	17,182
Pleasant Valley...	58,725	21,001	88,094	48,568	146,315	40,882	.....
Rice...	46,714	10,005	57,635	16,349	97,338	25,536	.....
Rush.....	79,118	21,263	107,911	33,001	232,981	49,087	.....
Scales Mound.....	38,389	16,029	67,872	33,397	131,728	30,974	9,554
Stockton.....	75,962	30,238	114,348	52,298	231,714	75,760	7,772
Thompson.....	58,220	16,143	83,253	31,118	157,315	45,327	.....
Vinegar Hill.....	34,344	9,657	38,449	13,043	92,690	13,606	.....
Ward's Grove....	43,023	15,484	61,498	26,780	138,099	33,627	.....
Warren.....	94,636	43,042	153,313	90,737	158,022	183,383	174,252
West Galena.....	215,761	67,430	326,822	372,467	154,880	548,970	364,009
Woodbine.....	70,808	18,420	95,760	38,231	205,709	58,088	.....

NOTE.—The figures in the above table are taken from the collector's books in the vault of the office of the county clerk, Galena, Illinois.

TABLE IV.—*Valuation of real estate and personal property of the towns in Jo Daviess County, 1880–98.*

	1880.			1885.		
	Lands	Personal property.	Town lots.	Lands.	Personal property.	Town lots.
Apple River	$78,187	$49,148	$23,931	$84,870	$33,500	$23,367
Berreman	56,663	27,763	.....	69,614	27,506	.....
Council Hill	64,561	26,507	756	71,695	30,229	680
Derinda	124,029	92,473	.....	138,494	75,975	.....
Dunleith	212,473	49,797	.....	226,586	28,343	49,847
East Galena	99,557	64,782	34,130	100,518	47,497	25,784
Elizabeth	151,780	157,408	22,490	161,160	152,821	22,537
Guilford	115,362	45,460	.....	127,692	41,320	.....
Hanover	156,640	129,216	15,477	169,446	81,284	20,934
Menominee	91,760	45,289	.....	90,342	28,194	.....
Nora	182,764	64,302	15,692	201,423	59,156	13,880
Pleasant Valley	120,390	48,815	.....	136,421	63,649	.....
Rawlins	.....	.....	.....	.....	.....	.....
Rice	71,504	30,147	.....	83,017	26,289	.....
Rush	147,081	52,302	153	163,659	51,838	.....
Scales Mound	84,481	51,684	9,374	88,517	34,370	11,995
Stockton	157,501	100,434	4,377	181,761	88,790	5,505
Thompson	115,428	43,968	.....	132,705	46,007	.....
Vinegar Hill	57,446	30,742	.....	62,052	20,614	.....
Ward's Grove	102,622	30,641	.....	116,757	38,660	.....
Warren	122,235	130,344	113,878	121,564	119,141	100,451
West Galena	88,703	360,352	202,032	102,481	315,746	192,008
Woodbine	143,466	57,597	.....	151,547	55,616	.....

TABLE IV.—Continued.

	1890.			1895.			1898.		
	Lands	Personal property.	Town lots.	Lands	Personal property.	Town lots.	Lands	Personal property.	Town lots.
Apple River...	$67,418	$27,018	$14,219	$65,730	$22,975	$18,886	$59,434	$16,960	$17,287
Berreman.....	56,217	25,706	.....	56,536	21,289	.....	53,979	12,285	.....
Council Hill..	57,550	23,801	648	57,914	18,794	655	53,032	13,983	411
Derinda.....	114,672	65,251	.....	120,164	44,991	.....	111,176	37,702	.....
Dunleith.....	170,252	26,069	51,160	222,154	23,922	44,275	212,380	24,010	42,171
East Galena...	80,917	44,823	28,850	78,439	34,474	27,248	67,415	33,175	24,694
Elizabeth.....	132,156	152,007	19,165	133,700	120,786	22,509	120,517	45,962	22,998
Guilford.....	101,321	42,833	.....	87,519	28,678	.....	67,481	21,905	.....
Hanover	138,822	74,441	24,189	141,779	73,256	25,187	129,258	68,069	28,081
Menominee....	88,175	29,642	.....	89,921	25,523	.....	83,684	19,178	.....
Nora	160,926	49,396	11,446	134,088	38,240	11,085	117,323	30,030	9,150
Pleasant Val..	114,328	56,660	.....	121,846	49,846	.....	108,156	36,678	.....
Rawlins.....	60,061	15,807	.....	60,770	15,178	.....	54,217	9,426	.....
Rice.....	65,929	22,853	.....	64,775	17,515	.....	61,213	14,889	.....
Rush.....	134,429	43,595	.....	134,299	28,696	.....	121,292	26,920	.....
Scales Mound.	68,402	30,481	15,031	66,863	19,153	13,247	51,557	14,564	.....
Stockton.....	185,838	94,599	18,355	187,433	97,038	30,216	165,096	64,746	32,522
Thompson.....	97,695	35,100	.....	91,015	24,036	.....	81,755	21,246	.....
Vinegar Hill..	54,277	17,353	.....	59,713	13,004	.....	53,461	11,206	.....
Ward's Grove.	98,923	33,801	.....	92,343	18,178	.....	82,128	16,193	.....
Warren.....	98,372	112,250	84,945	98,782	78,723	84,473	91,561	60,720	78,889
West Galena..	24,124	171,475	188,569	21,463	144,248	168,593	20,091	120,008	154,205
Woodbine.....	132,618	54,084	2,515	144,120	43,353	2,537	131,717	44,505	3,159

NOTE.—The figures in the above table are taken from the collector's books in the vault of the office of the county clerk, Galena, Illinois.

TABLE V.—*Votes for governor, in the towns of Jo Daviess County, 1838–48.*

	1838.		1842.		1846.		1848.	
	Whig.	Democrat.	Whig.	Loco-foco.	Whig.	Loco-foco.	Whig.	Loco-foco.
Apple River	40	12	74	110	68	21	109	24
John McDonald's	32	56	.....	.....	320	233	.....	.....
East Fork	59	4	126	28	170	97	127	44
Pleasant Valley	16	11	7	25	31	31	34	42
Menominee	25	11	25	57	25	80	32	82
Plum River	10	10	9	12	15	19	17	42
Elk Horn	28	3	.....	.....	.....	.....	.....	.....
Vinegar Hill	27	7	63	76	50	99	54	129
Savannah	54	30	.....	.....	.....	.....	.....	.....
Imus	16	16	25	34	.....	.....	.....	.....
West Galena	399	281	.....	.....	.....	.....	.....	.....
East Galena	59	26	.....	.....	15	14	53	3
Galena	.....	.....	446	533	530	706	678	705
Craig's Mill	.....	.....	72	19	.....	.....	.....	.....
Mill Creek	.....	.....	34	5	28	37	80	84
Ward's Grove	.....	.....	14	15	32	22	40	34
Irish Hollow	.....	.....	.....	.....	16	14	29	20
Millville	.....	.....	.....	.....	82	121	81	84
Council Hill	.....	.....	.....	.....	.....	.....	86	31
Elizabeth	.....	.....	.....	.....	.....	.....	210	203
Weston	.....	.....	.....	.....	.....	.....	80	11

TABLE VI.—*Votes of the towns in Jo Daviess County for members of Congress, 1844–94.*

	1844.		1850.		1854.		1856.		1858.		1860.		1862.		1866.	
	Whig.	Democrat.	Whig.	Loco-foco.	Whig.	Democrat.	Republican.	Democrat.	Republican.	Democrat	Republican.	Democrat.	Republican.	Democrat.	Republican.	Democrat.
Apple River...	92	21	84	37	....	....	....	....	....	....	....	....	28	18	82	72
Berreman.....	....	....	....	....	....	....	....	....	38	20	45	27	28	10	43	19
Council Hill..	....	....	68	28	97	41	70	19	78	27	114	22	90	21	97	17
Derinda.....	....	....	....	....	31	15	63	33	73	32	98	0	71	38	82	30
Dunleith.....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	93	86
East Galena...	49	21	25	68	121	33	182	133	....	....	197	167	135	185	167	123
Elizabeth.....	....	....	113	128	128	25	179	63	168	73	206	77	138	83	210	43
Guilford.....	....	....	....	....	70	32	78	72	76	90	103	106	87	89	76	63
Hanover.....	....	....	....	....	82	4	138	36	120	27	150	52	102	49	130	50
Menominee....	23	69	5	69	2	59	92	135	43	180	110	150	64	186	2	67
Nora.....	....	....	....	....	66	15	101	44	115	47	148	47	85	55	126	44
Pleasant Val..	19	48	16	22	28	15	84	44	66	34	80	61	61	64	35	71
Rice.....	....	....	....	....	....	....	....	....	..	....	19	49	33	23	49	16
Rush.....	....	....	....	....	37	10	87	37	118	36	134	36	89	20	123	21
Scales Mound.	....	....	....	....	....	....	55	50	62	70	64	58	31	56	54	54
Stockton.....	....	....	..	....	52	13	110	47	101	47	152	65	99	64	127	44
Thompson.....	....	....	....	....	48	0	82	28	70	34	54	36	34	32	50	35
Vinegar Hill..	69	105	90	107	23	35	46	72	57	81	69	95	51	83	43	93
Ward's Grove.	22	22	40	32	16	10	47	23	38	21	51	24	37	30	33	32
Warren.....	....	....	....	....	48	17	145	40	167	65	220	97	175	55	284	24
W. Galena, 1st.	237	309	135	341	473	238	314	298	247	350	272	296	200	323	244	207
2d.	252	476	88	229	....	....	192	269	206	203	375	330	166	222	197	195
Woodbine.....	....	....	....	....	54	19	103	32	97	39	118	46	73	39	100	37
East Fork.....	121	49	46	43	....	....	....	....	....	....	....	....	....	....	....	....
Plum River...	9	12	13	42	....	....	....	....	....	....	....	....	....	....	....	....
Mill Creek....	44	119	49	77	....	....	....	....	....	....	....	....	....	....	....	....
Irish Hollow..	22	16	31	34	....	..	....	....	....	....	....	....	....	....	....	....

TABLE VI.— Continued.

	1874.		1878.			1882.			1886.			1890.		1894.			
	Republican.	Democrat.	Republican.	Democrat.	Prohibition.	Republican.	Democrat.	Greenback.	Republican.	Democrat.	Prohibition.	Republican.	Democrat.	Republican.	Democrat.	Prohibition.	Populist.
Apple River.	65	100	80	16	88	92	82	1	95	77	16	53	149	115	101	13	....
Berreman...	40	17	41	6	15	44	20	5	48	21	....	54	36	45	30	4	....
Council Hill	78	41	95	9	29	97	9	....	91	22	....	65	27	68	19	....	....
Derinda.....	49	49	55	12	37	48	61	....	66	25	3	58	86	85	58	1	1
Dunleith...	118	95	114	60	11	88	137	....	54	149	....	108	177	124	101	2	5
East Galena	120	225	136	127	72	128	222	....	153	218	5	132	244	150	198	6	6
Elizabeth...	183	76	176	33	37	174	51	....	176	61	19	182	100	198	88	20	5
Guilford	54	124	69	35	43	83	82	....	76	118	....	74	132	100	96	....	....
Hanover.....	91	63	109	7	98	133	45	4	165	45	25	160	157	253	151	....	....
Menominee .	9	121	2	69	2	5	113	....	2	125	....	4	146	12	134	....	....
Nora	70	93	95	24	52	98	59	22	114	43	17	95	104	94	64	10	6
Pleasant Val	54	70	45	14	75	50	85	15	56	73	4	50	83	69	72	5	....
Rawlins.....	....	....	....	....	....	....	....	....	....	....	....	42	22	42	23	....	....
Rice.....	41	35	42	25	7	55	20	....	47	31	2	44	46	39	41	2	....
Rush.....	116	53	127	8	45	130	24	5	154	31	16	147	66	138	56	10	3
Scales Mo'nd	64	71	85	33	23	82	58	1	94	58	....	98	60	89	58	12	1
Stockton....	86	109	102	14	84	108	67	30	117	74	16	176	123	256	112	26	2
Thompson...	70	55	68	17	30	68	39	1	90	45	....	82	77	97	54	....	....
Vinegar Hill	35	123	43	35	43	47	55	....	56	70	.. .	42	72	38	65	2	....
Ward's Gr...	20	28	13	24	7	30	38	2	29	34	34	27	47	34	46	3	....
Warren.....	247	67	285	33	32	234	67	7	246	68	15	226	130	255	107	23	1
W. Gal'a, 1st.	191	318	185	244	78	....	....	....	148	217	7	163	268	183	217	5	3
2d.	175	341	210	252	43	368	616	....	110	190	4	90	171	99	138	2	....
3d.	....	....	....	....	....	....	....	....	128	206	1	136	205	141	174	3	1
Woodbine...	84	47	94	23	12	109	33	....	125	44	4	113	60	115	51	3	2

NOTE.—1844, John McDonald's gave Whig, 286, Dem., 302; Imus, Whig, 49, Dem., 45; Old Town, Whig, 93, Dem., 34. 1850, West Galena at East Fork of River gave Whig, 48, Dem. 35; Elizabeth at Weston, Whig, 46, Dem., 9; Millville. Whig, 71, Dem., 70.

TABLE VII.—*Votes of towns in Jo Daviess County in presidential elections, 1840–96.*

	1840.		1844.		1852.		1856.		1860.		1864.		1868.		1872.	
	Whig.	Democrat.	Whig.	Democrat.	Whig.	Democrat.	Republican.	Democrat.	Lincoln.	Douglas.	Republican.	Democrat.	Republican.	Democrat.	Republican.	Democrat.
Apple River...	146	104	....	....	90	51	....	....	....	....	54	23	92	86	102	76
Berreman....	....	....	....	....	....	....	....	....	45	27	46	15	50	21	66	16
Council Hill..	....	....	....	....	86	23	68	20	114	22	97	18	126	25	98	18
Derinda.....	....	....	....	....	....	....	61	34	98	41	98	45	88	40	75	45
Dunleith.....	....	....	....	....	....	....	....	....	....	....	....	....	139	114	118	100
East Galena...	42	7	....	....	72	78	175	143	192	171	156	165	192	164	180	206
Elizabeth.....	....	....	....	....	171	129	179	62	205	78	186	58	234	65	201	69
Guilford.....	....	....	....	....	....	....	78	72	103	108	93	85	107	85	86	90
Hanover.....	....	....	....	....	....	....	129	137	149	50	108	52	163	52	149	64
Menominee....	39	2	12	41	....	....	91	149	111	144	106	153	10	88	7	110
Nora	....	....	....	....	....	....	102	43	148	45	118	46	150	52	122	46
Pleasant Val..	31	23	47	41	47	39	81	44	80	61	66	84	54	56	63	54
Rice.....	....	....	....	....	....	....	....	....	49	19	47	33	71	16	50	36
Rush.....	....	....	....	....	....	....	87	37	124	36	109	27	139	30	153	30
Scales Mound.	....	....	....	....	....	....	55	49	64	56	57	50	80	55	83	43
Stockton.....	....	....	....	....	....	....	110	47	152	65	140	57	164	72	159	58
Thompson.....	....	....	....	....	....	....	81	28	54	36	46	37	66	40	80	45
Vinegar Hill..	81	20	65	106	44	89	46	73	62	95	43	64	50	104	55	106
Ward's Grove.	....	....	24	28	57	39	47	23	51	24	42	38	48	45	32	18
Warren	....	....	....	....	....	....	144	39	217	98	322	57	215	42	267	57
West Galena:																
1st precinct.	505	397	782	920	175	293	295	298	259	291	193	243	249	297	207	298
2d precinct.	....	....	....	....	246	295	177	280	372	330	263	332	229	261	233	386
Woodbine.....	....	....	....	....	....	....	104	81	118	46	119	40	125	49	124	87
East Fork.....	94	26	110	51	57	43	....	....	....	....	....	....	....	....	....	....
Craig's Mill...	91	18	78	23	....	....	....	....	....	....	....	....	....	....	....	....
Mill Creek....	32	11	30	16	68	87	....	....	....	....	....	....	....	....	....	....
Imus	49	27	50	61	....	....	....	....	....	....	....	....	....	....	....	....
Plum River...	18	77	7	23	30	57	....	....	....	....	....	....	....	....	....	....
Irish Hollow..	....	....	16	6	73	34	....	....	....	....	....	....	....	....	....	....

TABLE VII.— Continued.

	1876.			1880.			1884.		1888.			1892.				1896.	
	Republican.	Democrat.	Greenback.	Republican.	Democrat.	Greenback.	Republican.	Democrat.	Republican.	Democrat.	Prohibition.	Republican.	Democrat.	Populist.	Prohibition.	Republican.	Democrat.
Apple River..	108	98	5	103	79	25	104	84	96	105	21	104	111	0	14	139	101
Berreman....	65	27		69	43	1	78	30	63	48	1	57	43	0	7	71	39
Council Hill.	107	17	1	110	20	0	94	19	83	24	2	72	20	0	0	75	23
Derinda.....	85	46	9	87	51	5	73	62	71	84	0	70	96	0	1	112	59
Dunleith.....	117	113	1	117	113	0	150	133	122	161	0	122	142	0	0	144	169
East Galena.	184	205	0	168	235	1	147	233	157	252	5	150	236	7	5	225	176
Elizabeth....	228	83	1	225	76	3	184	67	193	96	21	195	92	7	15	246	111
Guilford.....	101	111	2	107	180	0	83	133	87	116	0	66	145	2	0	100	96
Hanover.....	163	86	5	195	57	28	210	74	184	101	19	182	88	68	12	253	151
Menominee..	12	126	0	9	158	0	6	139	9	143	0	10	155	0	0	25	130
Nora.	122	53	19	134	71	9	124	68	103	70	25	89	97	7	12	107	103
Pleasant Val.	72	62	34	70	90	27	67	102	58	104	4	59	103	2	7	99	83
Rawlins.....	....	....	....	..	....	....	....	....	41	28	0	43	27	0	1	43	18
Rice..... ..	64	40	0	77	41	0	7	35	68	46	2	42	48	13	1	74	44
Rush.....	172	29	15	182	40	19	179	52	171	58	13	158	68	6	9	186	68
Scales Md....	91	61	2	110	64	0	97	66	98	71	6	107	68	0	5	125	53
Stockton.....	138	87	20	110	99	24	139	105	176	114	9	236	145	1	14	292	131
Thompson....	90	58	6	111	55	4	95	61	103	69	0	91	72	3	0	124	45
Vinegar Hill.	53	113	0	49	85	0	47	75	37	79	4	37	72	1	3	51	65
Ward's Grove	37	40	1	45	39	2	32	54	23	47	0	33	53	0	1	46	40
Warren	316	56	13	298	86	19	253	93	249	122	34	235	132	5	21	305	130
West Galena																	
1st precinct	211	371	2	459	695	0	393	730	167	277	8	178	280	2	3	266	181
2d precinct	227	351	1	....	....	..	....	....	95	196	4	83	196	1	1	134	135
3d precinct	....	....	....	....	....	....	....	....	124	243	1	130	236	1	2	185	169
Woodbine....	144	48	3	134	58	1	134	62	140	65	6	131	72	3	1	167	57

NOTE.—McDonald's, 1844: Whig, 339, Democrat, 308. West Galena, East Fork of River, 1852: Whig, 80, Democrat, 64. Elizabeth at Weston, 1852: Whig, 37, Democrat, 3. Millville, 1852: Whig, 112, Democrat, 102.

TABLE VIII.—*Votes on constitutional revision. Votes on township organization.*

	Revising constituti'n Aug. 7, 1846.		Adoption of constitution, Mar. 6, 1848.		Convention to amend constitution, Nov. 6, 1860.		New constitution, Nov. 4, 1862.		Article prohibiting banks, Nov. 4, 1862.	
	For.	Against.	For.	Against.	For.	Against.	For.	Against.	For.	Against.
Apple River	72	0	68	0	.....	.....	17	40	23	32
Berreman	.....	.....	.....	.....	56	16	15	44	25	2
Council Hill	.....	.....	.....	.....	136	0	14	82	19	77
Derinda	.....	.....	.....	.....	27	112	36	65	54	46
Elizabeth	.....	.....	179	17	217	24	60	181	82	159
East Galena	20	7	.....	.....	315	49	180	97	193	72
Guilford	.....	.....	.....	.....	17	189	59	111	141	27
Hanover	.....	.....	.....	.....	101	1	47	96	47	89
Menominee	76	15	.....	.....	184	70	146	81	160	64
Nora	.....	.....	.....	.....	196	0	47	118	60	105
Pleasant Val	52	5	37	1	9	131	69	75	103	40
Rice	.....	.....	.....	.....	19	49	7	42	40	7
Rush	.....	.....	.....	.....	170	0	26	113	51	83
Scales Mound	.....	.....	.....	.....	110	13	44	47	46	45
Stockton	.....	.....	.....	.....	216	0	27	132	73	65
Thompson	.....	.....	.....	.....	85	0	16	63	66	12
Vinegar Hill	137	0	49	35	7	157	72	84	93	22
Ward's Grove	.....	.....	49	3	56	19	26	40	40	26
Woodbine	.....	.....	.....	.....	50	105	28	111	119	20
Warren	.....	.....	.....	.....	318	0	44	172	43	168
W. Galena, 1st	378	155	318	10	503	1	246	190	268	156
2d	430	13	478	7	669	1	258	184	274	160
McDonald's	395	29	.....	.....	.....	.....	.....	.....	.....	.....
Plum River	27	0	23	0	.....	.....	.....	.....	.....	.....
Mill Creek	14	9	44	1	.....	.....	.....	.....	.....	.....
East Fork	90	0	95	12	.....	.....	.....	.....	.....	.....
Millville	32	0	78	16	.....	.....	.....	.....	.....	.....
Elizabeth at Weston	.....	.....	32	4	.....	.....	.....	.....	.....	.....

TABLE VIII.— Continued.

	Constitutional convention call, Nov. 3, 1868.		Article concerning colored persons, Mar. 6, 1848.		Exclusion of negroes and mulattoes, Nov. 4, 1862.		Negroes not to hold office or vote, Nov. 4, 1862.		Laws excluding negroes from coming to Illinois, Nov. 4, 1862.	
	For.	Against.	For.	Against.	For.	Against.	For.	Against.	For.	Against.
Apple River	89	88	80	15	50	6	56	0	55	1
Berreman	6	64	.....	.....	24	1	21	0	26	0
Council Hill	126	3	.....	.....	17	77	58	33	20	74
Derinda	84	40	.....	.....	82	17	94	4	85	15
Dunleith	133	114	.....	.....	.....	.....	.....	.....	.....	.....
Elizabeth	239	50	167	27	158	68	209	12	193	27
East Galena	159	59	.....	.....	216	30	233	17	218	17
Guilford	107	21	.....	.....	150	18	166	3	154	14
Hanover	138	73	.....	.....	47	94	47	94	47	94
Menominee	10	86	.....	.....	165	50	217	3	167	31
Nora	135	1	.....	.....	53	112	72	90	59	104
Pleasant Val	54	86	30	8	101	22	108	18	104	19
Rice	71	10	.....	.....	43	5	46	1	45	3
Rush	141	16	.....	.....	68	66	84	47	79	49
Scales Mound	23	25	.....	.....	46	45	84	5	81	9
Stockton	157	7	.....	.....	63	65	125	7	75	45
Thompson	57	48	.....	.....	26	50	66	11	36	1
Vinegar Hill	0	154	69	10	88	20	87	16	86	12
Ward's Grove	44	38	26	22	41	20	53	10	43	10
Woodbine	94	52	.....	.....	127	2	126	2	121	2
Warren	322	4	.....	.....	82	126	136	73	84	69
W. Galena, 1st	242	279	197	101	313	95	378	16	318	49
2d	224	309	296	151	340	74	387	14	322	38
Plum River	.....	.....	21	2	.....	.....	.....	.....	.....	.....
Mill Creek	.....	.....	40	4	.....	.....	.....	.....	.....	.....
East Fork	.....	.....	85	9	.....	.....	.....	.....	.....	.....
Millville	.....	.....	50	41	.....	.....	.....	.....	.....	.....
Elizabeth at Weston	.....	.....	15	21	.....	.....	.....	.....	.....	.....

TABLE VIII.— Continued.

	Township organization. April 4, 1854,		Township organization, April 7, 1857.	
	For.	Against.	For.	Against.
Berreman	.....	.....	45	0
Council Hill	4	110	26	18
Derinda	38	13	47	16
Elizabeth	86	36	34	37
East Galena	34	26	26	48
Guilford	52	10	30	76
Hanover	88	11	97	6
Menominee	17	13	155	0
Nora	45	2	46	0
Pleasant Valley	48	0	55	0
Rush	72	4	.....	.....
Scales Mound	.....	.....	14	39
Stockton	72	1	96	8
Thompson	32	1	36	36
Vinegar Hill	9	18	88	0
Ward's Grove	49	0	44	1
Woodbine	72	2	54	14
Warren	26	11	139	10
West Galena, 1st	13	159	471	27

NOTE.—The general confusion due to the enlistment of troops and the prosecution of the war diverted the attention of the people from the great issues at stake when the election for members of a constitutional convention occurred in November, 1861. But little attention was paid to the selection of delegates, and the result was that of the seventy-five members elected, the Democrats, whose leading men were watchful of their advantage secured forty-five, and the Republicans only twenty-one, while seven were classed as fusionists, and two as doubtful. The constitution evolved by this convention received 125,052 votes in favor of its adoption, and 141,103 votes against its adoption. (See Election Returns, No. 3, page 1, Office of Secretary of State, Springfield, Ill.) The result in Jo Daviess County is given in detail in the table (Column 4).

TABLE IX.—*Votes on miscellaneous questions. Question of allowing animals to run at large on highways.*

	Two mill tax to pay state debt, March 6, 1848.		Prohibition law, June 4, 1855.		Railroad loan, Nov. 3, 1857.		Congressional apportionment laws, Nov. 4, 1862.	
	For.	Against.	For.	Against.	For.	Against.	For.	Against.
Apple River...	62	5	.....	.....	.....	.....	17	40
Berreman.....	.....	.....	.....	.....	0	38	19	8
Council Hill..	.....	.....	47	22	4	45	15	31
Derinda.....	.....	.....	30	42	3	34	38	64
Elizabeth.....	133	58	147	69	3	64	65	175
East Galena...	.....	.....	74	173	54	120	177	97
Guilford.....	.....	.....	40	90	2	64	59	109
Hanover.....	.....	.....	70	47	.....	.....	47	34
Menominee....	.....	.....	2	74	6	185	143	77
Nora	.....	.....	71	23	5	75	46	120
Pleasant Val..	2	36	33	26	.....	.....	68	70
Rice.....	.....	.....	.....	.....	.....	.....	5	44
Rush.....	.....	.....	52	36	64	10	28	113
Scales Mound.	.....	.....	35	38	2	91	45	47
Stockton.....	.....	.....	41	48	4	58	24	110
Thompson	.....	.....	39	31	1	56	15	63
Vinegar Hill..	12	70	21	46	6	70	72	42
Ward's Grove.	29	19	12	22	6	14	26	40
Woodbine.....	....	.....	62	20	2	18	32	107
Warren.....	.....	.....	76	38	3	136	48	164
W. Galena, 1st.	182	116	204	497	221	0	243	184
2d.	278	170	113	143	184	11	259	176

TABLE IX.—Continued.

	To allow animals to run at large, Nov. 5, 1872.		To allow animals at large, Apr. 6, 1875.		TO ALLOW ANIMALS TO RUN AT LARGE, APRIL 5, 1887.							
					Horses.		*Cattle.*		*Hogs.*		*Sheep.*	
	For.	Against.	For.	Against.	For.	Against.	For.	Against.	For.	Against.	For.	Against.
Apple River...	141	17	125	31	44	83	76	58	47	83	57	68
Berreman. ...	48	23	19	29	0	75	0	75	0	75	0	75
Council Hill..	58	51	83	18	38	67	48	55	27	79	45	60
Derinda.....	96	13	78	17	6	99	11	95	6	99	4	100
Dunleith.....	69	43	125	8	179	14	203	11	166	20	178	19
Elizabeth.....	188	41	177	34	99	73	126	47	100	77	105	66
East Galena...	228	50	239	38	157	133	175	121	147	149	159	133
Guilford.....	126	39	100	37	33	122	41	113	35	118	37	115
Hanover.....	172	25	151	52	93	86	120	68	53	125	62	109
Menominee....	52	58	41	51	9	109	8	110	10	110	9	111
Nora	61	88	45	65	15	97	34	88	12	97	14	97
Pleasant Val..	93	33	78	33	0	75	0	74	0	75	0	74
Rice..... ...	79	4	76	6	52	26	43	37	31	50	35	41
Rush.....	130	49	112	35	15	130	27	120	11	133	11	133
Scales Mound.	62	35	70	39	20	87	54	51	29	79	35	57
Stockton.....	113	100	56	103	5	119	5	119	5	119	5	119
Thompson	114	11	112	16	5	99	5	99	5	99	5	99
Vinegar Hill..	120	23	104	1	57	44	57	43	56	44	52	48
Ward's Grove.	46	14	32	7	3	43	8	39	3	43	3	43
Woodbine.....	125	40	117	12	13	97	16	96	14	97	12	98
Warren.....	169	79	117	122	18	168	109	94	14	168	17	166
W. Galena, 1st.	675	29	596	80	162	107	202	71	147	122	161	100
2d.	370	52	... ..	.....	119	98	149	73	112	108	128	93
3d.	.....	.....	.....	.....	238	42	261	26	221	58	216	58

The proposed mill tax voted for March 6, 1848, was to be devoted to paying the state debt incurred by internal improvements. On this question, Plum River voted, for, 11, against, 11; Mill Creek, for, 39, against, 5; East Fork, for, 49, against, 0; Millville, for, 44, against, 49; Elizabeth at Weston, for, 31, against, 5.

APPENDIX D.

The material in this Appendix was taken from the Dubuque County Records. The votes were found in several volumes called "Vote books." The property valuations were found in the assessors' books, in charge of the county auditor.

TABLE I.—*Vote of towns in Dubuque County, Iowa, in election of governor.*

TOWNS.	1857.		1859.		1861.		1863.		1865.	
	Dem.	Rep.	Dem.	Rep.	Dem.	Rep.	Dem.	Rep.	Dem.	Rep.
Cascade	67	30	100	49	25	49	126	46	101	44
Center	54	0	115	27	115	40	120	62	116	25
Concord	52	29	99	23	89	37	118	44	122	35
Dodge	10	10	36	34	34	50	51	53	51	55
Iowa	47	9	115	11	108	17	140	15	108	5
Jefferson	29	14	88	56	46	84	128	117	102	86
Julien (with city of Dubuque)	1,582	660	1,401	1,075	1,139	1,175	1,210	1,127	1,175	917
Liberty	64	11	153	12	181	17	246	21	137	3
Mosalem	47	3	115	13	125	22	134	20	72	13
New Wine	121	62	163	96	135	105	181	100	174	78
Peru	30	6	131	10	90	38	111	67	89	24
Prairie Creek	54	1	102	16	129	16	138	15	115	1
Table Mound	63	9	117	64	119	57	129	52	87	18
Taylor	54	63	65	102	56	131	81	150	98	125
Vernon	76	28	121	68	152	62	124	70	103	51
Washington	77	28	112	40	113	35	138	35	108	22
Whitewater	52	36	117	55	94	52	105	70	81	49

TABLE I.—Continued.

TOWNS.	1867.		1869.		1871.		1873.		1875.	
	Dem.	Rep.	Dem.	Rep.	Dem.	Rep.	Dem.	Rep.	Dem.	Rep.
Cascade	136	49	102	39	95	37	133	51	116	44
Center	117	43	97	49	95	41	106	44	98	47
Concord	101	44	125	30	141	37	145	44	138	56
Dodge	68	70	60	73	58	80	62	81	150	53
Iowa	108	8	111	10	106	8	84	20	111	30
Jefferson	127	100	125	79	109	78	143	68	133	83
Julien (with city of Dubuque)	1,518	1,117	1,379	1,212	1,395	1,260	1,452	1,305	1,790	1,314
Liberty	140	5	137	2	140	6	150	3	171	1
Mosslem	115	18	99	6	91	11	96	27	127	7
New wine	188	76	237	76	197	60	266	64	138	0
Peru	121	37	117	36	107	36	131	22	164	89
Prairie Creek	147	2	137	6	140	7	141	10	203	4
Table Mound	116	35	94	25	130	144	139	51	152	176
Taylor	103	150	100	150	114	145	122	145	101	27
Vernon	98	67	104	63	115	67	114	42	136	57
Washington	109	24	135	30	128	23	134	24	111	59
Whitewater	114	67	110	41	126	46	148	52	137	18

TABLE I.—Continued.

Towns.	1877.		1879.		1881.		1883.		1885.	
	Dem.	Rep.	Dem.	Rep.	Dem.	Rep.	Dem.	Rep.	Dem.	Rep.
Cascade	127	42	145	73	121	67	154	54	160	62
Center	88	24	139	46	133	46	125	29	135	22
Concord	115	28	117	57	139	47	147	37	164	58
Dodge	68	68	81	101	80	72	124	54	123	51
Dubuque	.....	.....	109	118	113	83	123	52	.....	.....
Iowa	110	15	134	18	114	10	132	2	140	9
Jefferson	92	71	157	109	100	82	151	65	127	60
Julien (with city of Dubuque)	1,566	1,014	1,507	1,438	1,732	1,760	2,673	1,747	2,868	1,723
Liberty	113	2	168	1	166	2	168	0	172	0
Mosalem	135	9	154	19	81	17	141	8	151	10
New Wine	300	47	383	70	316	74	416	22	377	45
Peru	114	5	117	48	69	60	123	23	124	34
Prairie Creek	97	0	123	1	116	1	48	3	185	6
Table Mound	135	60	108	80	111	89	159	57	157	91
Taylor	140	130	129	179	135	141	144	157	153	170
Vernon	67	32	132	49	109	45	112	45	159	42
Washington	55	10	121	19	105	23	95	29	116	27
Whitewater	93	31	126	67	124	50	153	57	168	54

TABLE I.—Continued.

Towns.	1887.		1889.		1893.		1895.		1897.	
	Dem.	Rep.	Dem.	Rep.	Dem.	Rep.	Dem.	Rep.	Dem.	Rep.
Cascade	154	58	187	72	168	69	171	69	186	78
Center	134	35	149	32	113	46	116	33	128	73
Concord	148	53	178	52	122	44	133	53	119	75
Dodge	113	42	142	54	163	49	129	47	125	59
Dubuque	124	90	112	65	136	90	140	89	158	118
Iowa	124	5	143	6	105	22	108	19	119	45
Jefferson	151	69	188	68	185	79	155	86	147	153
Julien (with city of Dubuque)	2,014	1,132	3,191	1,045	3,414	1,624	2,982	1,778	3,159	2,891
Liberty	190	0	213	1	207	3	156	7	127	36
Mosalem	106	12	135	6	102	10	83	12	98	28
New Wine	387	45	399	47	447	49	407	56	400	95
Peru	116	36	151	19	133	46	97	63	97	92
Prairie Creek	183	4	204	4	164	7	173	13	171	14
Table Mound	108	82	148	56	132	49	114	61	122	79
Taylor	146	159	199	173	167	199	171	205	183	245
Vernon	98	42	125	26	116	40	98	25	122	32
Washington	108	24	140	29	113	36	95	35	105	9
Whitewater	117	55	148	62	187	60	117	64	151	76

TABLE II.—*Population of Dubuque County, Iowa, from Iowa Historical and Comparative Census, Des Moines, 1883, pp. 474–5.*

TOWNS.	1852.	1854.	1856.	1859.	1860.	1863.	1865.
Cascade	513	655	899	.....	1,094	1,064	1,030
Center	718	781	1,185	.....	1,109	1,087	1,080
Concord	421	555	610	.....	1,061	1,057	960
Dodge	175	236	390	.....	611	661	695
Iowa	469	530	657	.....	807	825	690
Jefferson	562	824	1,111	.....	1,414	1,313	1,373
Julien	5,500	7,488	12,823	.....	14,319	13,991	17,082
Julien (with city of Dubuque)	.....	14,122	12,823	.....	27,319	26,617	22,596
Liberty	482	712	768	.....	1,185	1,179	1,133
Mosalem	551	544	795	.....	963	943	799
New Wine	420	615	1,010	.....	1,575	1,507	1,569
Peru	293	380	596	.....	833	948	902
Prairie Creek	277	447	608	.....	815	804	862
Table Mound	632	755	1,125	.....	1,112	1,127	935
Taylor	336	441	975	.....	1,134	1,160	1,369
Vernon	508	670	785	.....	1,145	1,138	1,060
Washington	410	523	776	.....	879	940	903
Whitewater	236	416	758	.....	1,088	1,019	631

TABLE II.—Continued.

TOWNS.	1867.	1869.	1870.	1873.	1875.	1880.
Cascade	1,076	1,213	1,289	1,102	1,029	1,231
Center	1,116	1,234	1,039	1,159	1,223	1,276
Concord	946	1,085	1,109	1,055	1,030	1,100
Dodge	872	758	979	1,010	825	1,144
Dubuque	.....	.....	.....	.....	.....	1,399
Iowa	832	861	878	824	842	768
Jefferson	1,160	1,391	1,550	1,526	1,578	1,595
Julien	22,589	19,447	19,849	23,436	24,955	22,254
Julien (with city of Dubuque)	43,811	37,531	38,253	45,587	48,560	.....
Liberty	1,140	953	1,102	858	924	949
Mosalem	778	732	972	751	667	900
New Wine	1,594	1,827	2,046	2,133	3,260	2,334
Peru	921	951	889	1,002	960	1,071
Prairie Creek	915	870	1,022	997	998	986
Table Mound	744	1,022	1,137	1,345	1,453	1,175
Taylor	1,190	1,473	1,742	1,688	1,833	1,668
Vernon	1,118	1,109	1,243	1,141	1,265	1,077
Washington	923	939	963	853	929	973
Whitewater	946	1,081	1,160	1,020	1,067	1,106

TABLE III.—*Dubuque County valuations of real estate and personal property.*

TOWNS.	1875.			1880.		
	Land.	Lots.	Personal property.	Personal property.	Land.	Lots.
Cascade	$117,208	$14,210	$36,886	$114,007	$171,327	$28,480
Center	98,922	995	25,885	29,042	116,739	1,500
Concord	98,600	.....	27,322	19,918	106,285	.....
Dodge	126,410	4,540	54,965	34,630	174,670	6,320
Iowa	124,611	.....	27,524	23,478	128,340	.....
Jefferson	103,172	.....	44,440	36,998	126,835	.....
Julien	216,567	21,870	1,836,470	1,668,691	208,852	3,497,220
Liberty	122,327	.....	37,970	37,802	152,775	.....
Mosalem	98,212	.....	26,035	18,770	81,042	.....
New Wine	196,257	.....	90,665	42,930	227,737	83,875
Peru	.....	.....	30,020	42,698	82,670	.....
Prairie Creek	153,930	.....	110,718	68,892	190,520	6,086
Table Mound	.....	.....	.....	68,555	166,266	5,375
Taylor	136,199	33,839	63,268	41,586	164,635	9,510
Vernon	2,302,975	182,572	44,497	37,139	188,507	2,380
Washington	203,993	.....	49,781	87,555	178,670	3,600
Whitewater	135,311	28,121	51,580	21,950	127,645	27,998

TABLE II.—Continued.

TOWNS.	1867.	1869.	1870.	1873.	1875.	1880.
Cascade	1,076	1,213	1,289	1,102	1,029	1,231
Center	1,116	1,234	1,039	1,159	1,223	1,276
Concord	946	1,085	1,109	1,055	1,030	1,100
Dodge	872	758	979	1,010	825	1,144
Dubuque	.....	.....	.....	.....	.....	1,399
Iowa	832	861	878	824	842	768
Jefferson	1,160	1,391	1,550	1,526	1,578	1,585
Julien	22,589	19,447	19,849	23,436	24,965	22,254
Julien (with city of Dubuque)	43,811	37,531	38,283	45,587	48,560	.....
Liberty	1,140	953	1,102	858	924	949
Mosalem	778	732	972	751	667	900
New Wine	1,594	1,827	2,046	2,133	3,260	2,334
Peru	921	951	889	1,002	960	1,071
Prairie Creek	915	870	1,022	997	998	986
Table Mound	744	1,022	1,137	1,345	1,453	1,175
Taylor	1,190	1,473	1,742	1,688	1,533	1,668
Vernon	1,118	1,109	1,243	1,141	1,265	1,077
Washington	923	939	963	853	929	973
Whitewater	946	1,081	1,160	1,020	1,067	1,106

TABLE III.—Continued.

TOWNS.	1895.			1899.
	Personal property.	Land.	Lots.	Personal estate.
Cascade	$103,430	$635,020	$4,080	$131,800
Center	34,860	569,420	.....	79,980
Concord	23,162	697,312	.....	93,672
Dodge	49,650	1,062,220	.....	176,116
Dubuque	50,370	880,795	93,360	133,080
Iowa	21,625	529,508	.....	90,340
Jefferson	39,190	647,850	.....	144,724
Julien	338,000	109,440	.....	1,983,710
Liberty	32,200	.....	.....	.....
Mosalem	20,390	443,430	.....	79,500
New Wine	131,730	.....	.....	.....
Peru	29,835	358,065	14,335	99,508
Prairie Creek	32,510	726,420	.....	100,853
Table Mound	30,570	867,420	.....	139,640
Taylor	92,620	681,055	86,564	262,028
Vernon	34,310	789,680	11,408	31,902
Washington	49,120	.....	.....	.....
Whitewater	131,645	637,392	.....	136,452

TABLE IV.—*Vote of towns in Dubuque County, Iowa, in election of president of United States.*

Towns.	1860.		1864.		1868.		1872.		1876.	
	Dem.	Rep.	Dem.	Rep.	Dem.	Rep.	Dem.	Rep.	Dem.	Rep.
Cascade	108	56	123	49	170	73	116	60	155	68
Center	93	29	140	34	136	69	87	66	168	55
Concord	106	42	125	37	137	50	114	49	156	58
Dodge	45	46	52	52	88	92	58	91	95	161
Iowa	116	14	127	19	130	11	107	14	143	28
Jefferson	106	74	130	95	158	112	116	105	169	22
Julien (with city of Dubuque)	1,321	1,241	1,347	998	1,719	1,596	1,591	1,524	2,295	1,834
Liberty	159	24	172	14	181	8	118	8	187	0
Mosalem	116	27	118	14	138	23	98	12	170	18
New Wine	169	111	182	64	233	88	241	59	385	85
Peru	83	44	100	32	121	56	117	41	140	46
Prairie Creek	107	22	134	10	179	9	125	11	132	1
Table Mound	.....	.....	118	37	150	57	87	54	177	88
Taylor	69	126	85	139	129	202	125	199	169	225
Vernon	103	87	119	65	123	78	132	55	136	76
Washington	113	47	141	29	150	26	117	22	149	28
Whitewater	116	57	104	54	149	83	124	60	150	65

TABLE IV.—Continued.

Towns.	1880.		1884.		1888.		1892.		1896.	
	Dem.	Rep.	Dem.	Rep.	Dem.	Rep.	Dem.	Rep.	Dem.	Rep.
Cascade	153	83	181	68	182	69	177	79	192	96
Center	141	76	193	47	160	41	138	54	111	102
Concord	150	60	188	61	168	57	152	51	142	61
Dodge	107	88	153	68	150	61	165	54	128	96
Dubuque	117	128	159	117	159	127	128	122	171	182
Iowa	137	9	152	19	160	25	131	23	130	142
Jefferson	157	152	172	124	181	103	162	90	157	158
Julien (with city of Dubuque)	1,912	1,801	2,902	2,150	2,851	1,966	3,902	2,570	3,598	3,665
Liberty	190	1	209	2	209	0	209	3	175	6
Mosalem	146	18	174	18	154	17	114	27	118	40
New Wine	398	74	416	57	441	51	450	53	397	110
Peru	131	62	164	42	164	52	139	63	110	129
Prairie Creek	144	2	189	9	179	9	175	15	224	5
Table Mound	128	77	155	108	149	98	149	74	151	96
Taylor	140	198	179	182	185	220	185	217	201	222
Vernon	145	63	142	59	150	60	144	53	144	55
Washington	145	29	144	44	152	29	133	29	146	42
Whitewater	153	86	163	71	157	69	168	73	192	96

TABLE V.—***Votes of towns in Dubuque County, Iowa, in election of members of House of Representatives.***

TOWNS.	1852.		1856.		1858.		1862.		1866.	
	Dem.	Rep.	Dem.	Rep.	Dem.	Rep.	Dem.	Rep.	Dem.	Rep.
Cascade	1	27	61	49	102	28	95	38	120	45
Center	64	23	76	24	106	28	149	44	104	50
Concord	16	19	14	26	93	22	117	38	94	43
Dodge	10	10	8	13	20	25	56	45	72	66
Iowa	38	20	46	23	92	13	130	18	114	8
Jefferson	46	21	48	16	65	28	78	98	106	111
Julien (with city of Dubuque)	454	305	1,044	743	1,421	918	1,250	942	1,239	1,271
Liberty	16	8	37	6	86	9	195	12	173	11
Mosalem	40	20	48	10	92	7	136	17	114	21
New Wine	27	7	73	42	139	77	141	99	186	79
Peru	32	3	60	7	81	6	94	21	100	40
Prairie Creek	25	14	50	12	76	11	136	14	115	5
Table Mound	45	22	80	14	123	18	116	40	114	1
Taylor	20	14	42	70	98	78	72	120	122	178
Vernon	24	28	60	43	135	75	122	43	114	80
Washington	25	8	70	23	87	28	133	25	117	24
Whitewater	30	29	54	51	109	55	86	58	120	64

TABLE V.—Continued.

Towns.	1870.		1874.		1878.		1882.		1886.	
	Dem.	Rep.	Dem.	Rep.	Dem.	Rep.	Dem.	Rep.	Dem.	Rep.
Cascade	115	46	98	52	156	62	150	72	166	70
Center	76	37	89	43	144	42	181	32	158	37
Concord	109	32	132	41	139	46	162	42	147	69
Dodge	42	76	64	68	96	87	119	78	133	72
Dubuque	.....	.....	.....	.....	121	94	128	120	151	106
Iowa	80	6	81	22	85	10	143	7	139	14
Jefferson	101	46	116	81	131	101	168	90	157	104
Julien (with city of Dubuque)	1,054	829	1,396	1,106	1,409	870	2,548	1,436	2,440	1,796
Liberty	100	9	128	3	156	0	162	7	198	1
Mosalem	72	12	89	4	120	7	142	8	129	14
New Wine	170	42	237	23	305	43	388	72	372	66
Peru	93	31	93	32	107	53	148	30	154	38
Prairie Creek	107	5	116	4	70	1	129	20	174	2
Table Mound	70	16	129	55	65	52	139	65	145	96
Taylor	70	146	127	167	118	163	163	149	155	184
Vernon	109	45	135	56	122	29	121	66	112	58
Washington	78	13	133	32	56	10	110	24	125	32
Whitewater	102	42	132	49	100	47	148	60	156	59

TABLE V.—Continued.

Towns.	1890.		1894.		1895.	
	Dem.	Rep.	Dem.	Rep.	Dem.	Rep.
Cascade	199	71	181	74	185	81
Center	152	39	127	60	86	86
Concord	165	54	143	50	128	63
Dodge	152	59	142	51	106	76
Dubuque	161	103	168	123	170	119
Iowa	157	25	120	37	102	48
Jefferson	189	105	147	114	173	136
Julien (with city of Dubuque)	3,441	1,910	2,483	1,964	2,342	2,618
Liberty	230	0	182	5	134	16
Mosalem	120	36	87	26	89	30
New Wine	494	31	407	63	352	100
Peru	149	61	104	54	96	109
Prairie Creek	161	21	171	8	134	10
Table Mound	172	68	130	65	127	90
Taylor	144	243	167	212	182	226
Vernon	153	42	111	34	109	32
Washington	136	32	129	33	136	46
Whitewater	144	81	135	74	171	80

SPIDERS OF THE PHIDIPPUS GROUP OF THE FAMILY ATTIDAE.

GEORGE W. PECKHAM, AND ELIZABETH G. PECKHAM.

In the following paper we have attempted to classify the spiders belonging to *Phidippus* and some related genera. Other genera must be included in this group but the work on them is not yet completed.

We are much indebted to M. Eugène Simon and to Mr. Nathan Banks for their generous assistance in lending us type species.

The drawings are by Mr. J. H. Emerton.

PHIDIPPUS (C. K.) 1846.

Megatimus Thorell, 1891, Spindlar Nikobarerna, p. 129.

Pl. XXIII, figs. 1–1b.

Spiders above medium size, sometimes very large and hairy.

The cephalothorax is high and massive, wide and rather short. As a rule the sides round out widely both from above below and from in front to the middle point. The widening from above below is usually more pronounced in the males than in the females. The cephalic plate slants forward. The thoracic plate is short and wide. The thorax falls from the dorsal eyes, at first gradually and then more steeply.

The quadrangle of the eyes is one-third wider than long, excepting in a few species, as *arizonensis,* which is one-half, and *opifex,* which is two-thirds wider than long. It occupies about two-fifths of the cephalothorax and is plainly wider behind than in front. The eyes are small in proportion to the size of the

spiders. The first row is curved, the middle being less than twice as large as the lateral and a little separated from each other, while the lateral are separated from them by from one-third to two-thirds of their own diameter. The second row is about twice as far from the third as from the first row. The dorsal eyes are as large as the lateral and form a row which is plainly narrower than the cephalothorax at that place.

The genus *Phidippus* has many species in North and Central America, and we have one species from South America. It was formed by C. Koch in 1846, the type being *variegatus* from New Orleans, *Die Arachn.* XIII, p. 125. In our *Attidae of North America* we cited *variegatus* as a synonym of *morsitans* Wlk., but since then we have received large collections from Mexico and Texas and are satisfied that it is distinct. *Mexicanus* P., and *Howardii* P. (Pl. XXIII, fig. 5), are also very close to *variegatus* (Pl. XXIII, fig. 4).

The descriptions and drawings of *P. obscurus* and *P. Rauterbergii,* in our paper on North American Attidae, were made from badly rubbed specimens and give but an imperfect idea of these species. We therefore redescribe their coloration from perfect specimens which we have recently received from Texas.

Mr. Workman's[1] drawing of the type of Thorell's genus *Megatimus* (Pl. XXIII, fig. 2), drew our attention to the fact that this genus strikingly resembled *Phidippus.* Mr. Workman very kindly sent us a specimen of the spider in question and we find that it conforms in all respects to *Phidippus.*

After an exchange of fresh specimens, Mr. Emerton agrees with us that his *P. multiformis* is distinct from our *P. rufus. P. multiformis, rufus* and *ruber* are close together but their distinguishing characteristics are brought out in the key.

Mr. Nathan Banks, in *Arachnida from Baja California,* Proc. Cal. Academy of Sciences, Third Series, Vol. I, No. 7, 1898, described several new species of *Phidippus.* He has kindly sent us specimens of these. We think that his *P. funebris* belongs in the genus *Parnaenus. P. fraternus* we believe to be identical with *Philaeus chrysis* Wlk., and *P. disjunctus* is the same as our *Philaeus fartilis.*

[1]Since the above was written arachnology has suffered a great loss in the death of Mr. Workman.

Illustrations of the palpi and epigynes of *multiformis, brunneus, galathea (mystaceus), ruber and morsitans* may be found in Emerton's *New England Attidae,* Pl. XVI: of the other species mentioned in this paper, in our *North American Attidae,* Plates I and II.

The structure of the bulb and tube of the palpus is so similar in *californicus, Tyrrellii, comatus* and *variegatus* that separate illustrations are not given.

The species of Phidippus, and especially the females, are exceedingly difficult to identify, and it is possible to do satisfactory work only where a large amount of material is accessible. While many of those described by Hentz are comparatively distinct, those of Walckenaer and Koch are frequently variations or immature forms of a single species and must forever remain uncertain. Any one working in this genus must recognize the futility of describing new species without a careful comparison of their relations, illustrated by drawings. We know of no systematic work that is more helpful, in this way, than that of Mr. J. H. Emerton.

We append a list of the species in our collection, with a key which will be found useful in determining them.

SPECIES IN OUR COLLECTION.

Phidippus ardens new, *arizonensis* P., *bardus* new, *californicus* new, *comatus* new, *cardinalis* H., *carneus* P., *farneus* P., *galathea* Wlk. (equals *mystaceus* H. and *albomaculatus* Keys.) *Georgii* P., *Howardii* P., *incertus* new, *insolens* H., *Johnsonii* P., *McCookii* P., *mexicanus* P., *miniatus* P., *montivagus* new, *morsitans Wlk.* (equals *audax* and *tripunctatus* H.), *multiformis* Em.,*obscurus* P., *octopunctatus* P., *opifex* McC., *otiosus* H., *princeps* P., *Putnamii* P., *Rauterbergii* P., *rimator* Wlk., *ruber* Keys., *rufus* H., *severus* Th. *(Megatimus), Tyrellii* new, *variegatus* C. K., *Workmanii* new.

Key to North and Central American Species of the Genus *Phidippus.*

MALES.

1		Abdomen with a covering of red hairs	2
		Abdomen without red hairs	8
2		First leg longer than second by tarsus, matatarsus and part of tibia	3
		First leg longer than second by not more than tarsus and metatarsus	4
3	a	Length 5-7 mm.; palpus with longitudinal white band above; cephalothorax black	*multiformis*
	b	Length about 9 mm.; palpus with longitudinal white band on upper surface of tarsus; cephalothorax	*insolens*
	c	Length about 13 mm.; palpus without white band on tarsus; cephalothorax black	*californicus*
4		Falces with fringe of white hairs down outer edge	*Tyrellii*
		Falces without fringe of white hairs	5
5		Long black hairs on first leg and on palpus; entire cephalothorax and abdomen deep red	*cardinalis*
		First leg and palpus without noticeable hairs	6
6		Length 10–12 mm.; color of abdomen deep red without black bands; cephalothorax black	*Johnsonnii*
		Length 6–8 mm.; color of cephalothorax and abdomen yellowish-red	7
7		Palpus with snow-white scales; falces dark, iridescent green	*rufus*
		Palpus without white scales; falces brown, not iridescent	*ruber*
8		Abdomen black, with a large triangular white spot and one or two pairs of smaller white spots behind	9
		Abdomen marked or colored differently from the above	11
9		Cephalothorax black	*morsitans*
		Cephalothorax with white bands on sides	10
10	a	Upper surface of thoracic region black; cephalothorax massive and plainly wider than third row of eyes; size, 11–15 mm.; first leg at least 12 mm	*variegatus*
	b	Upper surface of thoracic region entirely covered with white hairs; cephalothorax massive and plainly wider than third row of eyes; size, 11.4 mm.; first leg, 16.3 mm	[1] *mexicanus*
	c	White bands on sides of cephalothorax uniting to form a zig-zag band on upper surface of thoracic region; cephalothorax not massive and scarcely wider than third row of eyes; size 8 mm.; first leg, 10 mm	[2] *Howardii*

[1] Our specimen of *mexicanus* is shrunken. When fresh it would probably measure 15 mm.

[2] In *variegatus* there is sometimes a little reddish color on the patella of the first leg; in *Howardii* there is a decided tendency to red on the proximal parts of all the joints. The femur is dark in both species.

11	Fringes of fine, long, yellow hairs on all the legs, heaviest on those of the first pair	*arizonensis*
	Legs not fringed with yellow hairs	12
12	Falces iridescent	13
	Falces with white hairs or scales; not iridescent	14
13	First leg with a very heavy fringe of white hairs; size 8.5 mm	*comatus*
	First leg without heavy white fringe; first and second legs distinctly thickened; size about 10 mm	*galathea*
14	Falces entirely covered with long, soft, white hairs; no ridge of hairs above first row of eyes	*Putnamii*
	Upper two-thirds of falces covered with white scales; a ridge of rusty brown hairs above first row of eyes.	*obscurus*

FEMALES.

1	Red hairs on abdomen		2
	No red hairs on abdomen		6
2	Large spiders, more than 12 mm. long		3
	Medium sized spiders, usually not more than 10 mm. long		4
3	a	Tripunctate marking on abdomen consisting of a large central red spot and two smaller ones further back; red hairs on cephalic part	*miniatus*
	b	Body hairy; cephalothorax heavy and wide (4.6 mm.); falces green; first and second legs very heavy; third leg longer than second; abdomen red with central black band, and, at anterior end, a white band with a black band behind it	*carneus*
	c	Body not hairy; cephalothorax not wide (3.5 mm.) nor heavy; first and second legs not heavy; second and third legs equal; abdomen red, with central black band, and, at anterior end, a faint yellowish band with no black behind it	*ardens*
	d	Abdomen with herring-bone stripe; body not very hairy; cephalothorax small in proportion to size of spider; falces black; second leg longer than third	*Georgii*
4	Heavy looking cephalothorax which rounds out widely on the sides, and has the cephalic plate black, and the sides of a much lighter reddish brown color; legs barred with lighter and darker brown		*insolens*
	Cephalothorax not heavy looking; sides rounded out but not widely, as in *insolens*		5

5

a. Color brick-red; legs barred with lighter and darker brown; first and second legs very short in proportion to size of spider (total length about 11.5 mm., first leg about 7 mm.) — *rufus*

b. Color varying from yellowish brown to red;[1] legs barred with lighter and darker brown; first and second legs not short in proportion to size of spider (total length about 9 mm., first leg about 8 mm.) ..... *multiformis*

c. Cephalothorax and legs uniform dark brown or black; palpi dark; habitat, Florida, New Mexico ..... *rimator*

d. Cephalothorax and legs uniform dark brown or black; palpi pale brown; two bands of white, scale-like hairs on venter; habitat, Washington, California, Mexico ..... *Johnsonii*

e. Cephalothorax with narrow white bands along lower sides and wide white bands higher up, the space between being brownish; the wide white bands cross the clypeus and are continuous over the thoracic part; cephalic plate dark brown ..... *montivagus*

6

Upper surface of abdomen black with central white spot 7

Upper surface of abdomen brown, grey or yellow; or if black, having a pair of white spots on middle of dorsum 8

7

a. Abdomen with a white band around anterior end; and having a pair of white dots in front of central white spot, and two transverse or oblique white bars behind it; cephalothorax black, without white bands on the sides ..... *morsitans*

b. Abdomen with scalloped white band almost encircling the black upper surface, a pair of white dots in front of central white spot, and a pair of oblique white bars behind it; cephalothorax black without white bands ..... *farneus*

c. Abdomen with a central longitudinal scalloped black band enclosing a white spot; sides grey; cephalothorax black with a wide white band entirely surrounding the cephalic part ..... *Workmanii*

d. Abdomen with a white band around the front end and two or three pairs of oblique lines or spots behind the central spot; cephalothorax with wide white bands, which pass along the sides and meet on the thorax, and a narrow white crescent, which curves forward from the dorsal eyes on to the cephalic plate ..... *Rauterbergii*

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[1] Since the adult females of *multiformis* are usually orange or red it is classed among the red spiders, although this color is sometimes lacking.

8		Abdomen covered with yellow hairs	9
		Abdomen grey, brown, or black	10
9		Cephalothorax dark; integument of abdomen, as well as the hair covering it, yellow; falces rufus, not iridescent	*McCookii*
		Cephalic plate covered with yellow hairs; integument of abdomen dark red; falces iridescent	*bardus*
10	a	Markings on abdomen limited to a whitish band at anterior end and a single pair of white spots; length 8 mm	*princeps*
	b	Markings on abdomen limited to two pairs of white spots; length 15 mm	*opifex*
	c	Markings on abdomen consisting of numerous white spots and bands	11
11		Falces reddish-brown, not iridescent	*comatus*
		Falces with white hairs at upper end and brightly iridescent below	12
12		First leg a little (in large specimens plainly) longer than fourth	*otiosus*
		Fourth leg longest	13
13		Cephalothorax light colored and covered with short white hairs	*obscurus*
		Cephalothorax dark colored; covered with grey hairs.	14
14		Three white spots on cephalic plate; abdomen marked with white spots on a grey background; fourth leg scarcely longer than first	*incertus*
		Cephalic plate without white spots; abdomen with white spots on dark background; fourth leg plainly longer than first	[1] *galathe*

Phidippus ardens, sp. nov.

Pl. XXIII, figs. 7–7a.

This is a large, handsome species, with black cephalothorax and legs, and bright red abdomen.

♀. Length 14 mm. Legs 4123.

The cephalothorax is black, covered with yellowish hairs which form tufts in front of the dorsal eyes. The abdomen is bright red on the back, with a narrow black band down the middle. This band, which does not reach the anterior end, is

[1] When the hairs are rubbed from the abdomen of *galathea*, we have the form with the longitudinal forked band, described by Keyserling as *albomaculatus*. In other cases the posterior transverse bars are united, giving a puzzling likeness to *otiosus*.

broken at the edges by three pairs of red bars, the first pair near the middle, the others, less distinct, behind. There is a faint yellowish band around the anterior end of the abdomen, and below this and around the lower sides it is black. There is a thin covering of black and white hairs over the back. The falces are bright green. The palpi are dark brown with black and white hairs, and the legs black with yellowish hairs.

We have a single female from Santa Fé, New Mexico.

Phidippus californicus, sp. nov.

Pl. XXIII, figs. 3–3a.

A handsome spider of above medium size, with red abdomen, black cephalothorax and dark legs.

♂. Length 13. Length of cephalothorax 5.5; width, 4.5.

Legs 1423; those of the first pair longer than the body

The cephalothorax is black with a covering of coarse brownish hairs which grow long about the front part of the head. The falces are iridescent bluish-green. The abdomen is bright red with two longitudinal black bands which are broken in two places, behind the middle of the dorsum, by red bars. There is a narrow white band, scarcely visible from above, around the front and sides. Over the back is a thin growth of long brownish hairs. The legs are very dark brown, the first and second pairs being almost black. The first legs are more heavily fringed than the others, the hairs being brown on the femur, white on the patella, brown on the tibia (this joint is black and iridescent), white on the proximal halves of the metatarsus and tarsus, and brown on the distal halves. The palpus has white hairs and scales on the femur, patella, and tibia.

Californicus is too large to be taken for *rufus* (8.5) or *insolens,* (9.5), both of which have the cephalothorax red, and, moreover, neither of these species has been found further west than Colorado. It is most like *Johnsonii,* which is not much smaller, and is also found on the Pacific Slope. The coloration is similar, although *Johnsonii* has the abdomen crimson rather than red, with the black bands very indistinct or entirely lacking.

They may be distinguished by two points, the shape of the cephalothorax, which in *californicus* is nearly circular, being only 1 mm. longer than wide, while in *Johnsonii* it has a less rounded appearance, being, in fact, nearly 2 mm. longer than wide, and the relative length of the first leg, which in *californicus* exceeds the second by the tarsus, metatarsus and part of the tibia, while in *Johnsonii* it is longer by only the tarsus and a part of the metatarsus.

We have one male from California. It may, perhaps, be the mate of *P. ardens.*

Phidippus bardus, sp. nov.

Pl. XXIII, figs. 6–6a.

This rather heavy looking species is of somewhat over medium size. It is yellow, with the legs and palpi dark brown, and the falces iridescent.

♀. Length 11. Length of cephalothorax 4.5; width, 3.5. Legs, 4132.

The cephalothorax is dark reddish brown. The upper surface of the cephalic part and of the anterior thoracic, is covered with short, bright, yellow hairs. The abdomen has a dark reddish ground color, entirely covered with the same gold colored hairs, which have a much brighter effect here than on the cephalothorax. Under alcohol four pairs of indistinct white bars appear on the posterior part. Around the anterior end is a light colored band which runs down, obliquely, on the sides, and further back, on each side, is another oblique light-colored band. The falces are rugose and rather short, and are brilliantly metallic, with violet and green reflections. The palpi and legs are dark reddish brown, with snow-white scales and some long white hairs. The femur, patella, and tibia of the first leg are fringed on the underside, the patella with white, and the other joints with brown hairs. The femur has also a fringe of black hairs on the upper surface.

Red and orange are not uncommon colors among the spiders of this genus, but *P. McCookii* is the only other female where the hairs are really yellow, and in that species the ground color

of the abdomen is also yellow, the cephalothorax is all dark, and the falces are rufus, and not iridescent.

We have a single female from Long Island sent to us by Col. Nicholas Pike.

Phidippus comatus, sp. nov.

Pl. XXIII, figs. 8–8c.

This is a small species. The male is handsome, with gold-colored hair on the abdomen, and the first leg fringed throughout its length with long white hairs. The female is gray, with a white herring-bone stripe on the abdomen.

♂. Length 6.8. Length of cephalothorax 3.5; width, 3. Legs 1432.

♀. Length 10. Length of cephalothorax 3.5; width, 2.8. Legs 4132.

The male and female bear so little resemblance to each other that we put them together with some hesitation, although they were sent to us as one species. In the male the ground color of the cephalothorax is black. The sides are covered with white, and the eye-region with yellow hairs. In front of the dorsal eye and overhanging the eye of the second row, is a long tuft of stiff bristly hairs. The falces are slender and darkly iridescent, with green and violet reflections. On the clypeus and the inner edges of the falces are long white hairs. The abdomen has a thin covering of long hairs, which look brown, yellow, or whitish, according to the way the light strikes them. Under these is a coat of shorter gold-colored hairs around the anterior end and the sides. In the middle of the dorsum are two paler spots. In our specimen there is a dark central region, scalloped at the edges, extending from these spots to the spinnerets, which is rubbed entirely bare. The legs are barred with dark brown and black. The first one has a remarkably long fringe of snow-white hairs on the underside of all the joints, even extending on to the tarsus.

In the cephalothorax of the female the integument on the eye-region and on the sides and posterior part is black, but a band of bright reddish-brown runs across just behind the dor-

sal eyes. Our specimens are rubbed, but what hairs are left on the sides are white and there is a square patch of white hairs between the dorsal eyes. Over the eye of the second row is the same long stiff tuft that appears in the male. The falces are dark reddish-brown without iridescence. The abdomen is dark gray with a white band around the anterior end, and white bars on the sides. On the anterior part are four obliquely directed white spots, and on the posterior, two pairs of transverse bars, which are sometimes continuous at their outer ends, forming the parenthesis-like mark, which is also seen in *P. obscurus*. The legs are barred with light and dark brown and the palpi with brown and white.

The male of this species is distinct from all others by the fringe on the first leg. The female, although smaller, has some resemblance to *P. obscurus*, which comes from the same locality, but the cephalothorax is of a different shape, being slender, with the sides nearly straight, while in *obscurus* it is widely rounded. It differs also in having the first legs only slightly stouter than the others; in having the color grey instead of yellowish-brown; and in having the white spots on the abdomen joined to form a stripe instead of standing separate.

We have one male and three females, sent to us by Mr. Bolter, from Las Vegas, New Mexico.

Phidippus incertus, sp. nov.

Pl. XXIV, figs. 1–1a.

This is a gray species with white spots.

♀. Length 9–11 mm. Legs $\overline{4}13\overline{2}$.

The cephalothorax and abdomen are black, covered with gray hairs. There are three white spots on the cephalothorax just in front of the third row of eyes, and on each side of the head are two tufts of black hairs. The abdomen has a white band around the front end, and behind this, two pairs of white spots, the second pair being the larger. From above, the posterior part of the abdomen appears to be marked with two pairs of white bars. These extend downward on each side and join, forming a curved band. The palpi are brown covered with

white hairs. The legs are brown, with dark rings, and are covered with gray hairs, the first one having besides, a fringe of short hairs, which are white on the femur and patella, while on the tibia they are whitish on the first, and dark on the second half. The face and clypeus are covered with white hairs. The falces have the upper third black, and on this section grow white hairs. The lower part is very bright, iridescent green.

This species is almost exactly like *galathea,* but is smaller, and has a different epigynum. In *galathea,* moreover, the falces are iridescent to the very top and have only a few straggling white hairs along the inner edges. In *otiosus,* which is also much larger, the coloring is different, the hairs on the palpi and the spots on the abdomen being reddish, while the cephalothorax is high and narrow on top, that of *incertus* being rather low and wide.

Phidippus montivagus, sp. nov.

Pl. XXIV, figs. 3–3a.

This is a medium sized species, with a small cephalothorax and a heavy abdomen. The color is yellowish red.

♀. Length 11 mm. Legs $4\overline{123}$.

This species is characterized by the white bands on the cephalothorax. The cephalic plate, the middle sides, and the posterior thoracic part are dark brown, the cephalic plate having a growth of long, light brown hairs, which form tufts behind, and in front of, the dorsal eyes. Along the lower margin, on each side, is a white band, and another wider band, also white, extends around the front part of the cephalothorax and upper sides. The abdomen is covered with short yellowish red hairs, and has a white band around the anterior end which extends on to the sides. There is a darker band down the middle, and on this is a pair of central spots, and, further back, two pairs of bars, the hinder pair being close to the spinnerets. These spots and bars are not white, but are made of a mixture of white and red hairs, so that they are lighter than the ground color. The clypeus has long white hairs. The falces are dark and slightly

iridescent. The palpi are dark brown with white hairs, and the legs dark brown with light brown hairs.

We have a single female from Chihuahua, Mexico, where it was found by Mr. Townsend at a height of 7,000 feet above the sea.

Phidippus obscurus, P.

Pl. XXIV, figs. 2–2e.

A very handsome species of a gray or brown color, ornamented with snow-white bands and spots, which are edged with black.

♂. Length 10 mm. Length of cephalothorax, 4.8 mm.; width, 4 mm. Legs 1423; those of the first pair as long as the body.

♀. Length 10–13 mm. Legs 4132.

The cephalothorax is reddish-brown, covered with snowy white hairs. In the female there are long, stiff, black hairs around the eyes of the second row and on the middle of the cephalic part, while the male has a ridge of stout rusty-brown hairs beginning at each of the dorsal eyes and passing within the eye of the second row to just above the lateral eye, while a row of shorter hairs of the same color, above the first row of eyes, connects the ends of these two ridges. The male has also, low down on each side of the cephalothorax, between the dorsal and lateral eyes, a long tuft of the same rusty-brown hairs, and these are connected by a fringe of shorter hairs of the same color, which crosses below the first row of eyes, edging the clypeus, and hanging down over the falces. The falces are iridescent in both sexes, but while in the female there is a band of white hairs across the upper part, in the male they are almost covered with white rice-like scales passing into a stiff fringe of long white hairs, which look as if they had been cut squarely off. In our male specimen the abdomen has been rubbed, and shows only a dark brown integument with a thin covering of white hairs; it was probably like that of the female, which is of a delicate gray color. The pattern is essentially the same in both, and is made up of white bands and spots outlined in black.

There is a band around the anterior end, a pair of spots in front of the middle, a large central spot, two oblique bands on each side and a pair of spots in front of the spinnerets. The legs and palpi are brown, with a good many white, scale-like hairs. The first leg in the male has, at the inner, upper part of the distal end of the femur, a bunch of hairs, which are black with white tips. Running along under all the joints of this leg are two fringes of hairs of mixed colors, white, dark, and rusty-brown, these last growing white at the ends.

This species was described and named, some years ago, from a badly rubbed female specimen. It is, in reality, very distinct, the male, especially, being distinguished from all others by the hairs on the cephalothorax and falces.

We have one male from North Carolina and several females from Texas.

Phidippus Rauterbergii, P.

Pl. XXIV, figs. 6–6a.

Large, handsome spiders with metallic scales and white tripunctate marking on the abdomen.

♀. Length 13–16 mm. Legs $\underline{\underline{1423}}$.

The cephalothorax is dark brown or black, with a crescent-shaped white band which curves forward from the dorsal eyes. There are white hairs on the sides, and between the eyes of the first row. The abdomen is velvety black, with a pure white band around the front end, a white, central spot, two pairs of white spots further back, and two oblique lines on each side, the front one running lower down than the other. Behind the central white spot a bronze band runs to the spinnerets, and in front of the spot there is a less distinct bronze region, which sometimes appears as three indistinct spots, as is represented in the figure, and sometimes consists of a central band crossed by a line, the dorsum being thus broken into four black patches. The legs are black, barred with reddish brown, the first one having a double black fringe under the femur, and a single fringe of long hairs under the other joints. This fringe is white on

the patella, black on the tibia, white at the proximal and black at the distal ends of the metatarsus and tarsus. The falces are iridescent green.

This may very possibly be the female of *Phidippus variegatus*. We have several specimens from Texas.

Phidippus Tyrellii, sp. nov.

Pl. XXIV, fig. 4.

A medium sized species, with bands of white hairs along the outer edges of the falces.

♂. Length 9 mm. Length of cephalothorax, 4.5 mm.; width, 3 mm.

Legs 1423; first leg a little longer than the body; second leg scarcely longer than the third.

The cephalothorax is black, with wide white bands on the sides and above the first row of eyes. Overhanging these eyes, below them on the clypeus, and hanging down between the falces, are some long, whitey-brown hairs. The cephalic plate is covered with short brown hairs. The falces are iridescent green, with a streak of snow-white hairs along the outer edge, ending at the insertion of the fang. The abdomen, in our specimen, is badly rubbed, and shows only a low band of white around the anterior end, and behind this a good many bright red hairs which probably covered the dorsal surface. Under alcohol some pale markings appear, a large, central, triangular spot, posterior to this, two pairs of transverse bars, and, between these, a central spot, all of which were very probably covered with white hairs. The legs are very dark, almost black. The first is the stoutest, and is fringed, the hairs being colored as follows: on the upper surface of the femur they are dark; on the inner face they form transverse bars of white at the extremities, with an oblique black band between; on the outer face there is a white fringe along the lower edge, overhung by some darker hairs; on the patella and the proximal end of the tibia they are white, while on the distal end of the tibia they are inky black, and grow very thick, both above and below. Both metatarsus and tarsus have the proximal ends covered with white and the distal ends with black hairs.

This species is distinguished from all others by the longitudinal bands of white hairs on the iridescent green falces.

We have one male sent to us by Mr. J. B. Tyrrell, from the Canadian Rocky Mountains.

Phidippus Workmanii, sp. nov.

Pl. XXIV, figs. 5–5a.

This is a large species, the colors being gray, black, and white.

♀. Length, 14.5 mm. Legs, 4123.

The posterior thoracic part and the cephalic plate are black, the cephalic plate having a white spot in the middle. A wide band of white hairs crosses the clypeus, occupies the sides of the cephalic and anterior thoracic parts, and passes across the thorax behind the dorsal eyes. There are two tufts of black hairs on each side of the head. The abdomen is gray. Down the center is a scalloped, longitudinal black band, on which is a large triangular white spot, and further back, two pairs of white bars which touch the gray color of the sides. On each side is a pair of oblique white bars. The falces are bronze green. The palpi are yellowish, with white hairs. The first, second and third legs, excepting the metatarsi and tarsi, are rufus, the metatarsi being yellow except the distal third, which is rufus, and the tarsi being all yellow, excepting those of the first pair, which have a dark ring in the middle. The fourth leg has the femur and patella rufus, the tibia and metatarsus with the proximal half light colored, and the distal half dark brown, and the tarsus entirely light colored. All the legs are thinly covered with short white hairs.

We have a single female, in the Marx Collection, marked North America.

This species is very close to *farneus,* but the two pairs of white bars on the hinder part of the abdominal black band are transverse, not oblique, and are further apart. *Farneus,* moreover, lacks the white band on the cephalothorax.

Phidippus translatus, sp. nov.

Of this species we have one female from Santarem. It is so badly rubbed that a color description is impossible, but it appears to be exactly like *P. morsitans,* excepting in the form of the epigynum. It is the only representative of this genus that we have seen from South America.

Philaeus (Thorell), 1870.

Pl. XXIV, figs. 7–7c.

The cephalothorax is from moderately high to high, massive, and moderately long. The sides slant outward from the upper surface, especially in the males; they are narrowed in front and behind; in one species, *bicolor,* they are nearly parallel from just behind the second row of eyes to just in front of the posterior border, but in the others they are gently rounded. The cephalic plate is inclined forward. The thoracic plate is short and wide, the thorax slanting from just behind the dorsal eyes.

The quadrangle of the eyes is from a little more than one-third wider than long to nearly twice as wide as long, is equally wide in front and behind, or very slightly wider behind, and occupies two-fifths of the cephalothorax. The front eyes form a curved row, and are all separated, the lateral being further from the middle eyes than these are from each other. They are not large, the lateral being more than half the size of the middle eyes. The second row is slightly nearer to the first than to the third. The third row is not so wide as the cephalothorax at that place.

The relative length of the legs is 1243, 1423, or 4132.

Philaeus chrysis has the second row of eyes plainly nearer the first than the third row, as in *Phidippus,* but we place it in this genus because the quadrangle of the eyes is but little wider behind than in front. It has, moreover, metallic scales, which are not commonly found in *Phidippus.*

In distinguishing *Philaeus* from the closely allied genera we have made the following notes:

In *Phidippus* the cephalothorax is wider and shorter; the quadrangle of the eyes is plainly wider behind than in front; the second row of eyes is twice as far from the third row as it is from the first; the thoracic part is not so steeply inclined. In *Jotus* the quadrangle of the eyes is only one-fifth wider than long. In *Dynamius* the quadrangle of the eyes is only one-fourth wider than long, and the legs are nearly equal in length, the third and fourth, however, being longer than the first and second. In *Dendryphantes* the shape of the cephalothorax is different, being lower and flatter, without the distinctly raised cephalic plate. In *Servaea* the cephalothorax is not high as it is in *Philaeus,* and its upper surface is flattened. *Simaetha* has the lateral eyes of the first row widely separated from the middle eyes. In *Thyene* the cephalothorax is more rounded and has its highest point well behind the dorsal eyes.

Our collection has the following species belonging to the genus *Philaeus: chrysops Poda,* Dalmatia; *chrysis* Wlk., Guatemala; *bicolor* Wlk., France; *sanguinolatus* Wlk., Dalmatia; *fartilis* Peckham, Mexico; and *mexicanus* Peckham, Mexico. *Pl. orichalceus* C. K., which we formerly put into *Phidippus,* and *Phid. fraternus* Banks, are synonyms of *Philaeus chrysis. Phid. disjunctus* Banks is identical with *P. fartilis.*

Zenodorus Peckham, 1885.

Pl. XXV, figs. 1–1e.

In 1881 Thorell formed the genus *Ephippus* for *d'Urvillei* Walck. The name was preoccupied, and *Zenodorus* was substituted in 1885. It is characterized by the shape of the cephalothorax, which is very wide in front and narrow behind, and by the large eyes of the first row.

The cephalothorax is wide in front, and is high at the third row of eyes, from which it slants steeply in both directions. All of these points are exaggerated in the male. The quadrangle of the eyes is one-fourth wider than long, is wider in front than behind, and occupies one-third of the cephalothorax. The anterior eyes are in a plainly curved row, and are all large, the lateral being three-fourths as large as the middle. The

middle eyes are subtouching, the lateral a little separated from them. The second row is halfway between the first and the third, and the third is much narrower than the cephalothorax at that place.

We have only the type, from Murray Island, sent to us by Mr. Workman.

Parnaenus Peckham, 1896.

Attidae of Central America, Occ. Pap. Nat. Hist. Soc. of Wisconsin, Vol. 3, No. 1, p. 37, Plate XXV, figs. 2–2c.

The characteristic thing about this genus is that the front part of the cephalothorax is widely swollen, so that the greatest width is just behind the second row of eyes, this peculiarity being as marked in the female, at least in the type species, as in the male. Of other genera which resemble it in this respect *Thyene* is much smaller and is found in another part of the world, *Hyllus* has a differently shaped cephalothorax, with a high raised cephalic plate, and *Zenodorus* has the quadrangle of the eyes wider in front. *Parnaenus* is found in Texas, Mexico, Central America and South America. The spiders are large and handsome, the males being darker colored than the females, and, usually, having their first legs ornamented with fringes of hair.

The cephalothorax is high and massive, and when looked at from in front the sides are seen to bulge out on each side of the first row of eyes. The cephalic part is inclined. Behind the dorsal eyes is a depression and then a slight hump, from which the thorax falls in one slope to the margin. The lower outline of the sides is not far from circular, but there is a distinct bulge just behind the first row of eyes where the cephalothorax is widest. They round out widely from above downward so that although the dorsal eyes are on the sides, they form a row which is much narrower than the cephalothorax at that place. The quadrangle of the eyes is from slightly to plainly wider behind than in front, is barely one-fourth wider than long, and occupies about two-fifths of the cephalothorax. The first row is curved, the middle eyes being slightly separated, while the lateral are placed further back, with a distinct space between them and

the middle eyes. The middle eyes are nearly twice as large as the lateral. The second row is plainly nearer the first than the third. In the male the falces are strong and projecting, with a long fang, in *cyanidens* and *funebris,* but vertical in *griseus.* In both males and females, so far as we know them, the first leg is plainly the longest, and the fourth next.

This genus has for its type *Phidippus cyanidens* C. K., which we have from Texas, Mexico, Guatemala and Brazil. To this we add *Phidippus funebris* Banks, (*Arachnida from Baja California, and other parts of Mexico*), from Vera Cruz.

Parnaenus? griseus, sp. nov.

Pl. XXVI, figs. 7–7b.

Large spiders, black below and silvery gray above.

♂. Length, 11.5 mm. Legs, 1423, first stoutest. The first is longer than the second by the metatarsus and tarsus. The second and third differ but little. The fourth is longer than the third by the tarsus and half the metatarsus.

The cephalothorax, which is not much longer than wide, is highest behind the dorsal eyes. The quadrangle of the eyes is one-fourth wider than long, is plainly wider behind than in front, and occupies scarcely two-fifths of the cephalothorax. The palpi are stout. The maxillae are widened at the end, with a projection at the outer corner. The falces are stout, vertical, and not iridescent. The cephalothorax and abdomen are covered, above, with silvery gray hairs, which reach, on the sides of the cephalothorax to a little below the eyes. The lower sides of both cephalothorax and abdomen are black. There are long brown and white hairs scattered over the whole body. The legs are black, excepting the proximal halves of the tarsi, which are light colored with white hairs. There is a short thick fringe under the first leg, which is white on the patella and black on the tibia. The palpus has white scale-like hairs, and also long white hairs, on all the joints. With some hesitation, we place this species in the genus *Parnaenus.* The widest part of the cephalothorax is just behind the dorsal eyes, not so far back as is represented in the figure.

We have one male from Las Cruces, New Mexico.

Pardessus P., 1896.

For illustration, see *Attidae of Central America,* Pl. III, figs. 1–1b.

Rather large, handsome spiders, with distinct patterns.

The cephalothorax is rather high, with the upper surface level, or slightly convex. The cephalic part is slightly inclined; the thoracic falls little or not at all in the first half, and then slopes, not very abruptly, to the posterior margin. The thoracic plate is bluntly narrowed behind. The sides widen out gradually from the anterior end to the middle of the thoracic part, and then contract a little. They slant outward, so that the cephalothorax is considerably wider below than above. The highest point is at, or just behind, the dorsal eyes. The quadrangle of the eyes is less than one-fourth wider than long, is about equally wide in front and behind, and occupies two-fifths of the cephalothorax. The four anterior eyes are a little separated, the lateral more widely from the middle eyes than these from each other, and form a straight row. The second row is a little nearer the first than the third, and is narrower than the third, which is, itself, plainly narrower than the cephalothorax. The type of this genus is ***Plexippus mimicus,* O. K.**

Servaea Simon, 1888.

Pl. XXV, figs. 2–2b.

Journal Asiatic Soc. of Bengal, Vol. LVII, part 11, No. 3, p. 283.

The name *Servaea* was substituted for *Scaea* L. Koch., 1879, *Arachn. Australiens,* p. 1142, this being preoccupied.

This Australian genus is very close to *Philaeus,* the cephalothorax having the same long, nearly parallel sides, but the upper contour is quite different, *Servaea* having the dorsum nearly flat, while in Philaeus it is distinctly convex. The quadrangle of the eyes is one-third wider than long, and a little wider in front than behind, occupying two-fifths of the cephalothorax. The first row is slighty bent, with the middle eyes plainly less than twice as large as the lateral. The second row is about half way

between the other two, and the third is plainly narrower than the cephalothorax. The cephalothorax is not so high as in *Philaeus, Phidippus* and *Palestrina.* The cephalic part is only slightly inclined, while the thoracic is nearly flat in the first half, and then slopes off gradually.

We have specimens of *vestita,* the type, from New South Wales and Victoria. The relative length of the legs in the male is $14\overline{23}$, and in the female $41\overline{23}$.

Mollika gen. nov.

For illustration see *Arachniden Australiens,* Koch and Keyserling, Plate XCIV, figs. 7, 7a, 8–8c.

The cephalothorax is high, massive, and convex, and is nearly as wide as long; the sides slant outward from the upper surface and their outline from the front to the back is gently rounded, the widest point being behind the dorsal eyes. The cephalic part is inclined, and the thoracic falls in one slope from the second row of eyes to the lower border. The quadrangle of the eyes is one-fourth wider than long, a little wider in front than behind, and occupies two-fifths of the cephalothorax. The anterior eyes form a slightly curved row, the middle ones being subtouching, and the lateral a little separated from them and two-thirds as large, the relative size being the same as in *Zenodorus,* although the eyes, as a whole, are smaller. The second row is a little nearer the first than the third. The third row is as wide as the upper surface, but not so wide as the cephalothorax because of the widening out of the sides from above below. The legs are 1432, the first being plainly the longest, while the others are nearly equal.

This genus, which we form for *Philaeus metalescens* L. K., differs from most of the larger genera of the *Phidippus* group in the sloping thorax and the larger lateral eyes of the first row. In these points it agrees with *Zenodorus,* but this genus bulges out widely at the front end of the cephalothorax, while *Mollika* is widest in the middle. Into this genus we put *Jotus microphthalmus* L. K.

Palestrina gen. nov.

Pl. XXVI, figs. 4–4c.

This genus, while in size and general make up it recalls *Phidippus* and *Philaeus,* has a different look about the cephalothorax. The sides are high, but instead of being rounded off, they fall in a steep, straight slant. The dorsal surface, on the contrary, is more gently rounded than in those genera, the curve of the fall behind the dorsal eyes being just about equal to that in front of them. The sides are narrow in front but bulge out behind the dorsal eyes. The quadrangle of the eyes is one-fourth wider than long, is very slightly wider in front, and occupies two-fifths of the cephalothorax. The first row is very slightly curved and the middle eyes are larger than in the allied genera, being about twice the size of the lateral eyes. The second row is nearer the first than the third, and the third row is nearly as wide as the cephalothorax. In the species that we have of this genus the relative length of the legs is $\overline{4}312$, the third and fourth being plainly longest, and the first and second plainly stoutest. As compared with *Servaea*. *Palestrina* has the middle eyes of the first row relatively larger, the sides higher and steeper, and the quadrangle of the eyes wider behind.

Of this genus we have only *variegata,* a new species from Brazil.

Palestrina variegata sp. nov.

Pl. XXVI, figs. 4–4c.

♂. Length 9–10 mm.

Legs $\overline{4}3\overline{1}2$, first and second pairs stoutest. The third is longer than the second by the tarsus and half the metatarsus.

The cephalothorax is entirely covered with bright golden hairs. On the abdomen these gold-colored hairs are mingled with black ones to form a beautiful mottled pattern of spots and short wavy lines, which is very effective in an unusual style. The whole face, and the clypeus are covered with long yellowish white hairs which run down on to the dark colored, strong, vertical falces. The same hairs form a fringe on each side of the

palpus. The dark colored legs have some short snow white hairs on the tibia and metatarsus, but are not fringed. The metatarsi of the first and second, and the tarsi of the first, second, and third have the proximal ends light colored.

We have two females from Chapoda, in the Smith collection.

Hyllus C. Koch, 1846.

For illustration of *H. pterygodes* see *Arachniden Australiens,* Pl. CXIII, figs. 6–7.

In this genus the species are large, with long bodies, and with the first legs very long, only slightly thickened, and not hairy. In some of the species, and especially in the males, there is a bulging out of the sides of the cephalothorax. It is characterized by the high cephalic plate, like that of *Amycus.* Most of the species of *Hyllus* come from the Malay Archipelago but we have one, *pratensis* P., from Guatemala and Trinidad. We have also *giganteus* C. K., *Walcknearii* White, and *pterygodes* L. K.

The cephalothorax is very high, having the quadrangle of the eyes on a raised plate from which it slopes outward on the sides and behind. It is contracted in front and behind, the widest point being behind the dorsal eyes. The quadrangle of the eyes is one-fifth wider than long, equally wide in front and behind, and occupies two-fifths of the cephalothorax. The eyes of the first row are all separated and are large or moderately large, the middle being less than twice the lateral; they form a slightly curved row. The second row is plainly nearer the first than the third. The third row is not so wide as the cephalothorax at that place.

C. Koch founded this genus on *giganteus* in 1846. In the same year White formed the synonymous genus *Deineresis* for *Walcknaerii. Hyllus quadrilineatus, Wagae, nerreankii, minutus, fuscomanus, Cambridgii, callitherinus* of Taczanowskii, and *Hyllus tenuipes* of Keyserling are in our collection, but we do not include them in this genus.

The shape of *Hyllus* is more like that of *Amycus* than anything else, but the spiders are much larger, heavier, and deeper

colored. The males somewhat resemble the male of *Parnaenus funebris,* but the shape of the cephalothorax is quite different.

Simaetha Thorell, 1881.

Pl. XXV, figs. 3–3b.

This genus is identical with *Eulabes* Keys. 1882 and *Pirithous* Keys. 1883. The spiders are large, with rounded cephalothorax and long first legs, but are not so high and massive as *Phidippus* and *Philaeus.* They are characterized by the very wide quadrangle of the eyes and by the distance between the lateral and middle eyes of the first row.

The cephalothorax is moderately high and has a rounded appearance, both above and on the sides. The cephalic plate is inclined, especially in the anterior part. The thoracic part slopes off gradually in the first third and then more steeply. The highest point is at the dorsal eyes and the widest point behind them, where there is a gentle swelling out of the sides, excepting in *severa,* which is widest in front. The quadrangle of the eyes is about twice as wide as long, is much wider behind than in front, and occupies from two-fifths to one-half of the cephalothorax. The first row of eyes is straight or somewhat curved, with the middle eyes subtouching or a little separated, and more or less carried forward by a projection of the cephalothorax. The lateral eyes are separated from them by at least their own diameter. The second row of eyes is nearer the first than the third. The third row is about as wide as the cephalothorax at that place. The relative length of the legs is 1243 in the males, and 1423, 1423, or 1342 in the females.

This genus was formed by Thorell for *thoracica* (Studi sui Ragni Malesi e Papuani, III, p. 520). We lack this species, the genus being represented in our collection by *paetulus* Keys., (Pl. XXV, figs. 3–3b) *tenuidens* Keys., (Hasarius) *barbatissimus* Keys., and *severa,* a new species. In *barbatissimus* the cephalothorax is higher than in the others, and is a little differently shaped. *Severa* approaches *Anamosa* of the Homalattus Group, in its long cephalic part. All these species excepting *severa* are from Australia. Possibly the type, *thoracia* (Cape York), is identical with *S. fissidens* Keys., also from Australia.

Simaetha severa sp. nov.

♀. Length 6.6 mm. Legs 1423, first longest and stoutest.

In this species the quadrangle of the eyes is twice as wide as long, occupies one-half of the cephalothorax, and is much wider behind. The first row of eyes is straight; the middle eyes are large and subtouching; the lateral are nearly half as large, and are separated from them by their own diameter. The second row is very much nearer the first than the third. The cephalothorax is as wide as long, and is widest at the second row of eyes, where there is a distinct bulge. The falces are vertical, as wide as the first row of eyes, and flattened. The maxillae are rounded. The palpus has the patella, tibia, and tarsus flattened. The color is brown, the cephalothorax being covered with yellowish hairs above, and halfway down the sides and hinder slope. Where the sides bulge out in front these hairs grow long. The abdomen, in our specimen, is rubbed bare, showing only five pairs of indented dots.

We have one female from Singapore.

Thyene Simon, 1885.

Pl. XXV, figs. 4–4b.

Bull. Soc. Zool. de Fr. 1885, t. x, p. 4.

This genus covers several medium sized species (5–9 mm.) from the Eastern Hemisphere. In the males there is a characteristic bulging out of the sides of the cephalothorax which makes it resemble, on a much smaller scale, some of the males of *Parnaenus, Zenodorus* and *Hyllus* In both sexes the sides are distinctly rounded.

The cephalothorax is highest behind, or at, the dorsal eyes. The cephalic plate is strongly inclined and the thoracic part and the sides are much rounded. The widest point is just behind the dorsal eyes, excepting in the male of *bucculentum* where it is in front of the third row. The quadrangle of the eyes is one-third wider than long, is from a little (*imperialis*) to a good deal (*bucculentum*) wider behind, and occupies two-fifths of the cephalothorax. The first row of eyes is almost straight, with

the middle fully twice as large as the lateral, all separated. The second row is nearer to the first than to the third. The third row is narrower than the cephalothorax at that place. So far as we know the relative length of the legs is 1342 or 1342 in the male and 3412 in the female.

Simon founded this genus on *imperialis* Rossi, in 1876, calling it *Thya* (*Arachn. de Fr.,* Vol. III, p. 51). The name *Thyene* was afterward substituted for *Thya,* which was preoccupied. We have the type, from France, *tamatavi* Vinson, from Madagascar, *bucculentum* Gers. from Zanzibar and Madagascar, and *varians* new from Madagascar. Simon has described *T. semicuprea, Bull. Soc. Zool. de Fr.,* t. x, p. 4, and *T. squamulata, Ann. Soc. Ent. de Fr.,* 1886, p. 347.

Thyene varians sp. nov.

The males of this species are showy brown and white spiders, with a wide scalloped white band on the sides of the cephalothorax, and white hairs on the upper part of the falces. The female is indistinct.

♂. Length 5–7 mm. Legs 1324, first and third much elongated.

♀. Length 7 mm. Legs 3412, third and fourth plainly longest, and the first and second stoutest. The first and second are nearly equal in length, the third and fourth more unequal.

The first row of eyes is nearly straight and the lateral eyes are larger than is usual in *Thyene,* being more than half as large as the middle eyes. The quadrangle of the eyes is a little more than one-fourth wider than long, and is only slightly wider behind than in front.

In the male the ground color is brown. The cephalothorax has the clypeus and face white. There is a small tuft of black hairs, on each side, below the eye of the second row. The cephalic plate has a more or less triangular white spot in the middle, and two short snow white bands running back from the middle eyes of the first row to beyond the eyes of the second row. Around the lower margin is a narrow white line, and on the upper sides is a wide, scalloped, white band, which begins at

the lateral eyes, and is continuous on the hinder part of the cephalothorax. This wide band is connected with the marginal line by a white line at the back part of the thorax. The abdomen has a white longitudinal band down the middle which forms, at the anterior end, a large spot. Behind this there is an enlargement, and then a narrower part, which is crossed, back of the middle, by a curved transverse white band. The falces are vertical, about as wide as the middle eyes, with a small fang. Their color is brown, and on the upper half is a bunch of white hairs. The palpus has white scales along the top of the femur and patella, and at the proximal end of the tarsus, and white hairs on the sides of the tibia. The femur and patella are light colored, the tibia and tarsus dark. The first leg has the femur, patella, and tibia brown, and the metatarsus and tarsus light colored. There are white hairs on the proximal two-thirds of the patella, in a line along the outer upper edge of the tibia (which is covered underneath with short brown hairs), and in a ring around the proximal end of the metatarsus. The other legs have the femur light at the proximal, and dark at the distal end, and the other joints ringed with brown and white.

In the female the cephalothorax is covered with light brown hairs, with a not very conspicuous tuft on each side below the eye of the second row. The abdomen is covered with gray hairs. On each side are two oblique white bands, and on the hinder part of the dorsum are two pairs of white spots all outlined in black. The markings are indistinct. The legs are yellow with white hairs.

We have three males and one female from Madagascar.

Dendryphantes (C. K.), 1837.

For illustration of the type, see *Attidae of Central America,* Occ. Pap. Nat. Hist. Soc. of Wisconsin, Vol. III, No. 1, Pl. IV, figs. 3–3b.

This genus is widely distributed and has many species which resemble each other closely in form, color, and marking. They are usually from four to seven millimeters long. The cephalothorax is moderately high. The upper surface varies in its contour, but is never flat. Most commonly both cephalic and thor-

acic parts slope gradually from the dorsal eyes, the thoracic slant becoming steeper after the first third. The sides are but little wider below than above. They diverge very slightly from the first row of eyes, and are only a little wider than the third row, but behind this point they widen out. As a usual thing the front eyes form a curved row, the middle being less than twice as large as the lateral, and close together, while the lateral are a little separated from them. In some cases these eyes are close together in a straight row, and the middle eyes may be twice as large as the lateral. The quadrangle of the eyes is from one-fourth to one-third wider than long, is wider behind than in front, and occupies from two-fifths to one-half of the cephalothorax. The first and fourth legs are always longer than the second and third, the first leg being always longest in the male.

Hentz, in his *North American Spiders*, described a number of small *Dendryphantes* which are very difficult to identify. After comparing a large number of specimens from different parts of the country, we have concluded that *parvus* is the female of *capitatus*. Our *aestivalis* and also *aestivalis* Emerton, are identical with *capitatus*. We had supposed that *octavus* and *hebes* H. were also to be referred to this species, but Mr. Emerton writes to us as follows: "As to identification of Hentz's names it is not much more than guess work at best. I can agree with you on *capitatus* and *parvus* being probably the same species as our *aestivalis*, but *octavus* and *hebes* are quite as likely to be something else. I have just looked at the original colored figures in the Society of Natural History Library, and they are less like *D. aestivalis* than the engravings and descriptions." Our *D. alboimmaculatus* would better go into the genus *Ballus*. *D. vitis* of Cockerell, and our *D. elegaus*, we now think are better placed in Icius. *D. bifida* Banks and *D. aeneolus* Curtis are synonyms of *D. montanus* Emerton. We have compared them carefully and the only difference is that the joints of the palpus are heavier in *montanus* than in *aeneolus*. *Montanus* was published in the latter part of 1891, *aeneolus* early in 1892, and *bifida* in 1895.

Key to some of the males of the genus *Dendryphantes*, includ-

ing *felix, prosper, faustus, albopilosus, vigens, ruber, nitidus, laetabilis, octopunctatus, limbatus* Banks, *cuprinus* Tacz., and *tropicus.* In all of these species the first leg is long, often longer than the second by the tarsus, metatarsus and part, or all, of the tibia. In several other species the first leg is longer than the second by the tarsus and metatarsus, but in these all of the legs are relatively short, there being no appearance of a long first leg.

1. Falces long, horizontal and parallel, *felix* and *prosper.*

The general appearance of these species is almost exactly alike, but the relative length of the legs is 1 4 2 3 in *felix,* and 1432 in *prosper,* and the palpi are perfectly distinct, the tube being straight in *felix* and curved in *prosper.*

2. Falces moderately long to long, and oblique, *militaris, limbatus, nitidus* and *laetabilis.*

The falces of *laetabilis*[1] are stout and round, less than twice as long as wide, with two teeth on the lower side, and a long apophysis from the middle of the inner edge of each falx. The first leg is longer than the second by the tarsus, metatarsus, and nearly all of the tibia. There is no white band on the cephalothorax.

In *nitidus*[2] and *limbatus* the falces are long and rather slender, more than twice as long as wide, and the first leg is longer than the second by only the tarsus and metatarsus. *Nitidus* has a white band around the lower edge of the cephalothorax, but none on the upper sides, while *limbatus* has the marginal band, and wider ones running backward from the lateral eyes on to the thorax. *Militaris* differs from the other three in having white bands on the upper sides of the cephalothorax and across the cephalic part above the first row of eyes. For a good drawing of the falces of this species, see Emerton's *New England Attidae,* Pl. XVII, figs. 1b, 1c.

3. Falces swollen, vertical or slightly inclined, with white hairs on the front face, *albopilosus, vigens, faustus* and *octopunctatus.*

Albopilosus is distinguished from *vigens* by its coloring, from

[1]See Attidae of Central America and Mexico, Pl. IV, fig. 6a.
[2]See Attidae of Central America and Mexico, Pl. IV, fig. 8a.

faustus by having only one apophysis on the tibia of the palpus, and from *octopunctatus* by having the tube of the palpus long and spirally curved, instead of short and straight. *Vigens* is distinguished from *faustus* by having only one apophysis on the tibia of the palpus, and from *octopunctatus* by the tube of the palpus being curved. *Faustus* is distinguished from *octopunctatus* by having two apophyses on the tibia of the palpus.

4. Falces vertical or slightly inclined, not swollen, without white hairs on the front face, *cuprinus, tropicus* and *ruber.*

Tropicus is distinguished by the short curved horn on the under proximal part of each falx. *Ruber* is distinguished from *cuprinus* by having the falces equally wide throughout their length, instead of wide at the base and narrow at the end.

This leaves us a number of American species in which the first leg of the male is not strikingly long, the spiders being rather small, from 4.5 to 5.5 millimeters long. These species are *vegetus, perfectus, pernix, bisquepunctatus* Tacz., *montanus* Em., *capitatus* Hentz, *arizonensis, Manii, proxima, hondurensis, flavipedes, centralis* and *Smithii.* Of these, *vegetus* is distinguished by its golden-green coloring, without white bands; *perfectus* by the white band down the middle of the abdomen; *pernix* by the two pairs of curved white bands on the posterior part of the dorsum; *bisquepunctatus* by the curved horn (similar to that of *tropicus*) on the falces. The remaining species are very similar in form and coloring, and are best distinguished by the differences in the palpus. *Capitatus* has the tube doubled, coming off from the end of the bulb. *Montanus, proxima* and *hondurensis* have all a stout, straight tube from the end of the bulb, and must be separated by their specific descriptions. *Manii* and *Smithii* have a straight, slender tube from the end of the bulb, *Smithii* being distinguished from *Manii* by having the apophysis on the tibia of the palpus larger, and curved. In *arizonensis* there is a stout, curved tube from the side of the end of the bulb. In *centralis* the tube also comes from the side of the end, but is slender and curved. In *flavipedes* the tube is bifurcated to its insertion at the end of the bulb. This species has the first and second pairs of legs light brown with a black line along the anterior faces of the femur, patella and tibia.

Dendryphantes felix, sp. nov.

Pl. XXVII, figs. 6–6a.

♂. Length 5.5 to 6.5 mm. Falces 3 mm. Legs 1423 first stoutest and much longer than the others, the first being longer than the second by the tarsus, metatarsus and part of the tibia. The coxa and trochanter are elongated. In *A. diolenii* these joints reach to about half the length of the falx, in this species just to the base, while in *D. prosper* the coxa and trochanter are scarcely visible from above, and are much thicker than in *felix.*

The cephalothorax is plainly longer than wide; the cephalic part is slightly inclined, and the thoracic falls a little in the first two-fifths and then drops abruptly. The quadrangle of the eyes is one-third wider than long, is a trace wider behind than in front, and occupies two-fifths of the cephalothorax. The first row of eyes is straight, the middle are twice as large as the lateral, the former touching, the latter subtouching. The second row is nearer the lateral. The third is about as wide as the cephalothorax at that place. The falces are bronze brown in color, and are long, parallel, horizontal and cylindrical, with a very long fang. The maxillae are more than twice as long as the labium, divergent and rounded. The color of the cephalothorax is bronze, with red, iridescent scales on the upper surface, and around the first row of eyes, the scales being much more distinct in some lights than in others. There is a white spot just above the first row of eyes, and another further back and between the eyes of the third row. There are white bands on the upper sides, starting from the lateral eyes of the first row; they do not unite behind. The abdomen is bronze brown, with an encircling white band, which is not continuous behind. The bronze brown along the middle of the abdomen is much brighter and more iridescent than that on the sides. The first legs are dark, except the last joint, which is pale. The trochanters and proximal parts of the other three legs are light; the rest of the legs are dark until the metatarsi, the last two joints growing paler, the depth of color varying in different specimens and also on the different legs. All the legs have white hairs.

The femur and patella of the palpus are covered with white scales. The tube of the palpus distinguishes this species from *D. prosper.*

We have this species from San Rafael, Mexico, sent us by Mr. C. H. Tyler Townsend.

Dendryphantes prosper, sp. nov.

Pl. XXVII, figs. 5–5a.

♂. Length 6 mm.; length of cephalothorax 3 mm. Falces 2.5 mm. Legs 1432; first and second stoutest and first much longer than the others.

The cephalothorax is plainly longer than wide. The cephalic part is slightly inclined, and the thoracic falls a little in the first half and then drops abruptly. The quadrangle of the eyes is one-third wider than long, is wider behind than in front, and occupies two-fifths of the cephalothorax. The first row of eyes is straight, with the middle eyes sub-touching and twice as large as the lateral, which are separated from them. In our specimens the scales and hairs are so nearly gone that it is impossible to get a good idea of the coloration, but the cephalothorax seems to have been bronze, with red, iridescent scales on the cephalic plate, white bands on the upper sides, and a white spot between the dorsal eyes, while the abdomen is brown, with an encircling white band. The falces are bronze brown in color and are long, horizontal, cylindrical, and parallel, with a very long fang. The maxillae are more than twice as long as the labium, and are rounded and divergent. The legs are brown, the first and second pair darkest, with some close white scales. The palpus is brown, with short white hairs on the patella.

The general appearance of this species is exactly like that of *D. felix,* although there is a slight difference in the relative length of the legs, but the palpi are perfectly distinct, the tube being straight in *felix* and curved in *prosper.*

We have two males from San Antonio, Texas.

Dendryphantes limbatus Banks.

Arachnida from Baja, California, and other parts of Mexico. Proc. California Academy of Sciences, Third Series, Vol. I, No. 7, p. 282.

This species, which Mr. Banks places in the genus *Philaeus,* seems to be identical with *Philaeus consimilis* Banks, described in the same paper, p. 283.

♂. Length 5 mm; ♀ 5 mm. Legs ♂ 1423; first plainly the longest; ♀ 1423. Falces, ♂ 2.5 mm.; fang as long.

The cephalothorax is moderately high and has a rounded appearance, being nearly as wide as long. The first row of eyes is almost straight, the middle being subtouching and less than twice as large as the lateral, which are a very little separated from them. The second row is a very little nearer to the first than to the third, and the third is narrower than the cephalothorax at that place. The quadrangle of the eyes is one-third wider than long, and is wider behind than in front. The cephalic part is a little inclined, and the thoracic falls scarcely at all until the last third, when it drops abruptly. In the male the whole body is bronze. The eye-region and a central band down the dorsum of the abdomen are covered with green metallic scales. The cephalothorax has a white line around the margin, and a white band starting from the lateral eye and running back on to the thorax, but not quite uniting with its fellow of the opposite side. The abdomen has a white band around the base and sides, which does not reach the spinnerets. The female is similar, but lacks the white bands. The falces of the male are long, oblique, and divergent, with a strong tooth underneath, and a long, slender fang. In the female they are vertical and parallel. The coloring is bronze, with iridescent scales. The legs are dark brown with the tarsi pale, and the proximal ends of the femora lighter, especially in the third and fourth. The palpi are dark brown, those of the male having white scales and a row of short black spines on the rather elongated patella.

D. laetabilis has no white band on the cephalothorax and has the falces not long and slender, but heavy, with two teeth on the lower side, and a long apophysis from the middle of the inner edge of each falx.

as long. The anterior eyes form a curved row, the middle being less than twice as large as the lateral and subtouching, while the lateral are a little separated from them. The second row is nearer the first than the third, and the third is not so wide as the cephalothorax at that place.

The cephalothorax has the upper surface and the lower sides bronze. A white band passes backward from the lateral eye along the upper side on to the thorax, but does not unite with its fellow of the opposite side. The abdomen is bronze, with a white encircling band which grows narrower toward the spinnerets. On the dorsum are four pairs of indented dots. The legs are bronze, with all the joints darkening toward the distal ends. The femur is nearly black in the first leg, while in the others it is dark with a pale proximal end. There are white scales on all the joints. The palpus is brown. It looks rather like that of *octopunctatus,* but is not so long and slender, the tibia being shorter and broader (plainly smaller than the tarsus), with a longer and slightly curved apophysis. The tube from the end of the bulb is somewhat curled, while in *octopunctatus* it is straight. The falces are vertical and are swollen, like those of *octopunctatus, faustus,* and *albopilosus,* with white scales all over the front. The clypeus is narrow and dark. The maxillae are widened at the tip and are about twice as long as the labium, which is longer than wide.

The color of this species is entirely different from that of *albopilosus.* It is distinguished from *faustus* by having only one process on the tibia of the palpus, and from *octopunctatus* by the difference in the palpus.

We have one male from Para.

Dendryphantes faustus, sp. nov.

Pl. XXVII, figs. 1–1b.

Length, ♂ and ♀ 6 m. Legs, ♂ and ♀, 1423; the first very long (9 mm.) in the male.

In the male the cephalothorax and abdomen are bronze-brown, the cephalothorax with white hairs on the sides, and the abdomen with an encircling white band. On the clypeus and around the eyes of the first row are bright golden-red hairs.

The falces project slightly, and are divergent, and flattened on the inner side, with a rather long fang. On the flat inner sides, and along the inner edges, are pure white hairs, which have a very ornamental effect. The legs are brown, paler toward the terminal joints. The first leg has the coxa and trochanter elongated and visible from above, the coxa alone being longer than the coxa and trochanter of the second taken together. There are some short white hairs on the upper side of the femur, and under the patella. The palpus has two apophyses on the tibia, one long and blunt, one short and pointed. The maxillae are pointed.

The female has a brown cephalothorax, which seems to have been covered with white hairs, and there are long white hairs on the face and clypeus. The abdomen is reddish brown, with some white hairs at the anterior end. The sides are mottled with pale streaks. On the dorsum are two dark longitudinal bands, upon which are three pairs of pale dots, and, behind these, two pairs of pale bars. The falces are shaped somewhat like those of the male, but are vertical and have a short fang. On the inner faces are some short white hairs. The legs and palpi are barred with light and dark brown.

In its elongated first leg and general coloring, *faustus* resembles *Avitus diolenii,* but in that species the cephalothorax is much narrower behind than in front, and the middle eyes of the first row are twice as large as the lateral eyes.

Dendryphantes tropicus, sp. nov.

Pl. XXVII, figs. 8–8b.

Length, ♂ 4 mm.; ♀ 5.5 mm. Legs, ♂ 1 4 2 3; first stoutest and exceeding the second by the tarsus and metatarsus; ♀ 1 4 2 3, first stoutest.

The quadrangle of the eyes is one-fourth wider than long, occupies about half of the cephalothorax, and is equally wide in front and behind. The first row of eyes is straight, the eyes all close together, the middle being barely twice as large as the lateral. The second row is nearer the first than the third, which is plainly narrower than the cephalothorax at that place. The sides round out, being widest at the dorsal eyes.

Our specimens are rubbed. In the male the cephalothorax is dark brown and seems to have been covered with bronze scales. There are indications of a white encircling band. The lower margin has a very narrow white line. The abdomen is brown, the dorsum surrounded by a white band. The legs and palpi are of a medium brown with some darker bars. The palpus has a long, spiral tube. The falces are divergent, nearly vertical, with a fang as long as the falx; on the under proximal part just beyond the point of the maxilla, is a short curved horn, pointing toward the base. This is a characteristic point, as the only other species having such a process is *bisquepunctatus,* which is larger with a different palpus.[1] The falces are brown with brown hairs. The labium is a little longer than wide and a little less than half as long as the maxillae, which are excavated, truncated, and projecting at the outer corner. The female has the cephalothorax with light bronze scales, the sides and clypeus being white. The abdomen is brown with a central longitudinal band of light bronze, and an encircling band of yellowish white. In front of the spinnerets are two pairs of oblique white lines running from the central band to the white on the border.

We have two males and a female from Chapoda.

Dendryphantes cuprinus Tacz.

Pl. XXVII, fig. 7.

Length, ♂ 5 mm; ♀ 6 mm. Legs, ♂ 1243; first stoutest and longer than the second by the tarsus, metatarsus and nearly all of the tibia; second, third and fourth nearly equal; ♀ 1423, first much the stoutest.

The cephalothorax is narrow in front, widening out to a point behind the dorsal eyes. The sides are a little wider below than above. The quadrangle of the eyes is one-fourth wider than long, a very little wider behind than in front, and occupies nearly one-half of the cephalothorax. The anterior eyes are close together in a curved row, the middle being less than twice as large as the lateral. The second row is plainly nearer the first than the third, which is narrower than the cephalothorax.

The male has the whole body bright brown, covered with golden hairs which have a slight metallic lustre. The cephalo-

[1] Mohica Moenkhausii has a horn under the falx like that of *bisquepunctatus.*

thorax has white bands along the upper sides which unite behind and has some reddish hairs around the front eyes. The abdomen is encircled by a white band, and has, on the dorsum, eight indented dots, and a narrow streak of mixed black and white hairs down the middle of the posterior half. The legs are brown with some small white scales, those of the first pair being the darkest. The palpi are yellowish-brown with white scales on the femur and patella, and are marked by a very small apophysis on the femur, and a larger one on the tibia. The tube is narrow and straight. The falces are brown. They are vertical, stout above, but narrow at the end, where there is a little tooth. The fang is long and slender, the whole falx resembling that of *tropicus,* which, however, lacks the little tooth, and has a small curved horn on the upper part. The maxillae are twice as long as the labium, with projections at the outer corners. Our female is too badly damaged to describe, but the cephalothorax seems to have been dark brown with some iridescent red on the eye-region. According to Dr. Taczanowski's description the whole body is covered with fawn colored hair, the abdomen having a longitudinal brown band which is enlarged at the extremities and in the middle, and is bordered by a white line.

We have a male and female from Lima, sent to us by Dr. Taczanowski.

Dendryphantes pernix, sp. nov.

Pl. XXVIII, figs. 5–5a.

Length, ♂ 5.5 mm. ♀ 6.5 mm. Legs, ♂ and ♀ 1423, first stoutest in both sexes, with a distinct enlargement of the femur and tibia, which is more marked in the male than in the female.

The cephalothorax is nearly flat on the upper surface from the front row of eyes through two-thirds of the thoracic part, although there is a slight rounding up toward the dorsal eyes, in both directions. It widens out a little behind the middle, and is not much wider below than above. The front eyes form a very slightly curved row, the middle ones touching and less than twice as large as the lateral, which are separated from them. The

quadrangle is one-fourth wider than long, occupies more than two-fifths of the cephalothorax, and is but little wider behind than in front.

We have no perfect specimen, but the coloring seems to be as follows: The hairs on the sides of the cephalic part, and in a band along the upper sides of the thoracic, are white; on the upper surface of the cephalothorax, on the lower sides of the thoracic part, and in a median band on the slope of the thorax, separating the extremities of the white band, they are yellow. On the clypeus they are long, thick and white; and around the middle eyes of the front row they are yellowish. There is a narrow white line around the lower margin of the cephalothorax. The front end and the sides of the abdomen are covered with snow-white hairs. The dorsum shows traces of yellow hairs. On the posterior part there are two pairs of slightly curved transverse white bands which come up from the sides, very much as in *D. dubitabilis* and in several species of *Zygoballus*. In the male the first leg has the femur dark brown with a row of brown hairs, not thick enough to be called a fringe, above, and another below. The patella is light, the tibia dark with a fringe of brown hairs on the inner side, the metatarsus light in the proximal and dark in the distal end, and the tarsus dark. The second has the femur dark, the patella light but darkening a little at the distal end, the tibia dark and the metatarsus and tarsus light. The third and fourth have the femur dark, tending toward lighter at the proximal end, the patella and tibia light, darkening at the distal ends, and the metatarsus and tarsus light. In the female the first leg is dark except the metatarsus and tarsus, which are lighter, and the second, third, and fourth are light brown, the joints tending to grow a little darker at the distal ends. The falces project a little, and are brown, with some yellowish hairs on the inner face. The palpus is brown with white hairs on the femur, these being more marked in the male than in the female. The maxillae are truncated and project at the outer corner. They are twice as long as the labium which is but little longer than wide.

Whe have numerous examples from Chapoda.

Dendryphantes perfectus, sp. nov.

Pl. XXVII, figs. 4–4a.

♂. Length 6 mm. Legs $\overline{14}23$, the first longer than the second by the tarsus and metatarsus.

The cephalothorax is a little wider below than above, and the sides widen out slightly to a point behind the dorsal eyes. The quadrangle of the eyes occupies two-fifths of the cephalothorax, is one-third wider than long, and is wider behind than in front. The front eyes form a curved row, the middle being close together and less than twice as large as the lateral, which are a little separated from them, and placed further back.

The cephalothorax is dark reddish brown, with white bands along the upper sides which do not unite behind. The abdomen is bronze with a white band down the middle of the back, on each side of which is a pair of white spots. Around the front end and sides is a white band, which throws up two little points or projections on each side, at the posterior end. The legs are dark brown, the first pair almost black. The maxillae are short and rounded. The falces are brown, vertical, and have a small tooth on the inner side at the end. The palpus is dark brown with the tarsus as long as the patella and tibia together. There is a process on the tibia, and the tube, coming off from the end of the bulb, is straight and narrow.

This species, of which we have one male from Para, sent to us by Mr. Moenkhaus, is near *cuprinus, tropicus* and *ruber*. Of these *cuprinus* and *ruber* have the first leg longer than the second by the tarsus, metatarsus, and nearly all of the tibia, and *ruber* has the patella and tibia of the palpus plainly longer than the tarsus, while *tropicus* may be distinguished by the falces.

Dendryphantes vegetus, sp. nov.

Pl. XXVIII, figs. 7–7a.

♀. Length 4.5–5 mm. Legs 4132, first a little the stoutest.

The cephalothorax is small in proportion to the abdomen, and has the sides nearly parallel, there being a slight widening behind the dorsal eyes. The cephalic part is plainly inclined.

The thoracic falls gradually in the first third, and then steeply. The quadrangle of the eyes occupies two-fifths of the cephalothorax, is one-third wider than long, and is a little wider behind than in front. The front eyes are small, and form a slightly curved row; they are all close together, and the middle ones are less than twice as large as the lateral. The second row is nearer the first than the third, and the third is nearly as wide as the cephalothorax at that place. The whole spider is covered with bright greenish golden hairs, the green tint being less marked on the abdomen than on the cephalothorax. When the hairs are rubbed off, the abdomen is light brown with two darker bands on the anterior part, which merge into dark chevrons behind, and dark oblique streaks on the sides. The falces are light brown, vertical, and rather long. The legs and palpi are yellow with some white scales. The lip is wide and short, the maxillae twice as long, and rounded.

We have many females from San Rafael, Mexico, sent to us by Mr. Townsend.

Dendryphantes odiosus, sp nov.

Pl. XXVIII, figs. 6–6a.

♀. Length 4.5—5.5 mm. Legs $\overline{4123}$, first stoutest.

The cephalothorax is very little longer than wide; the widest point is behind the dorsal eyes; the upper surface rounds off gently in each direction from the dorsal eyes, the thoracic slope becoming steeper after the first half. The sides are not much wider below than above. The quadrangle of the eyes is one-third wider than long, wider behind than in front, and occupies two-fifths of the cephalothorax. The front eyes are rather small and form a straight row, the middle ones touching, and a little less than twice as large as the lateral, which are separated from them. The second row is a little nearer the first than the third, and the third is nearly as wide as the cephalothorax at that place. We have no perfect specimen, but in one which is in fairly good condition the upper surface of the cephalothorax seems to have been entirely covered with yellow hairs, excepting a white spot between the dorsal eyes, and the sides are entirely covered with

white hairs. Around the two middle eyes of the first row the hairs are reddish, but on the clypeus and the upper part of the falces they are yellowish white. The abdomen seems to have had the dorsum with yellow hairs, and four or five pairs of white spots, while the sides are brown with oblique white bands. The legs are brown with white scales and hairs, and the palpus is brown with thin white hairs on the tarsus. The maxillæ are rounded, with a projection at the outer corner, and are twice as long as the labium, which is as wide as long.

We have four females from Chapoda.

Dendryphantes fortunatus, sp. nov.

Pl. XXVIII, figs. 8–8a.

A very distinct and handsome little species.

♀. Length 4 mm. Legs 1432, first darkest and having the femur, patella and tibia enlarged.

The cephalothorax is plainly longer than wide. It is narrow in front, widening a little beyond the third row of eyes. The quadrangle of the eyes is one-third wider than long, occupies nearly one-half of the cephalothorax, and is very slightly wider behind than in front. The anterior eyes are all near together in a straight row, the middle being nearly twice as large as the lateral. The second row is nearer the first than the third, and the third is almost as wide as the cephalothorax. The cephalothorax is red brown above, with two dark spots on the eye-region, and has the sides and clypeus covered with white hairs. The abdomen has an encircling band of silvery white, and above this, on each side, a brown band speckled with white, which has a raised appearance, and which is cut by three narrow, oblique, strips of white. Down the middle, between the two dark bands, is a light brown, somewhat metallic, band. The first leg is dark, the second pale, the third and fourth yellow, excepting the femoral joints, which are dark. The palpus is pale yellow. The falces are dark brown, short, vertical, and rounded.

We have a single female from Brazil.

Dendryphantes Manii, sp. nov.

Pl. XXVIII, figs. 1–1a.

♂. Length 4 mm. Legs 1423.

The front eyes are in a curved row, the middle ones close together and twice as large as the lateral, which are well separated from them. Our specimen is rubbed badly. The cephalothorax has the eye-region dark brown, and slightly iridescent, with two black spots in the middle. There is a white line around the margin and white hairs grow all over the sides, and on the posterior thoracic part. The abdomen is encircled by snow white hairs. The dorsum shows a yellow background with a dark longitudinal line crossed by a shorter one in the anterior part and three dark chevrons behind. The legs are yellow with brown marks, the femur of the first being brown. There are white hairs on the clypeus and around the front eyes. The falces are oblique and divergent, with a long tooth at the distal end, opposite the insertion of the fang. On the the inner faces are snow white hairs. The palpus is yellow except the tarsus, which is dark brown. The maxillae are nearly three times as long as the labium, and are truncated, with projections at the outer corners. The labium is about as long as wide.

We have one male from Arizona, sent to us by Mr. Alfred Mann.

Dendryphantes arizonensis, sp. nov.

Pl. XXVIII, fig. 2.

♂. Length 5 mm. Legs 1423.

The cephalothorax is narrow in front but widens in the thoracic part. The quadrangle of the eyes is one-fourth wider than long, is wider behind than in front and occupies two-fifths of the cephalothorax. The front eyes form a curved row, the middle subtouching and twice as large as the lateral, which are a little separated from them. The cephalothorax, including the clypeus, seems to have been entirely covered with yellowish white hairs. The abdomen is encircled with a band of the same color. The middle part of the dorsum, in our specimens, is

rubbed bare, but under alcohol, it shows on the anterior part, a dark, diamond-shaped spot on a lighter background, and, further back, three dark chevrons. The posterior part has three pairs of black spots just at the edge of the white. The legs are brown, darkest at the distal ends of the femoral joints. The palpi and falces are brown, the falces projecting and diverging, with two teeth on the lower margin. The maxillae are truncated, with a projection at the outer corner, and are a little more than twice as long as the lip, which is about as long as wide. In *D. Manii*, which is somewhat like this species, the maxillae are nearly three times as long as the lip.

We have one male from Arizona.

Dendryphantes proxima, sp. nov.

Pl. XXVIII, figs. 3–3a.

Length, ♂, 5 mm. ♀, 5 mm. Legs, ♂ 1423, ♀ 41$\overline{32}$, first stoutest.

The quadrangle of the eyes is one-fourth wider than long, occupies two-fifths of the cephalothorax, and is wider behind than in front. The front row of eyes is bent, the middle close together, and nearly twice as large as the lateral, which are a little separated from them. The coloration is very like that of *D. capitatus*. In the male cephalothorax the upper surface is covered with white hairs excepting a yellow patch in the middle, just above the front eyes. On the sides, the cephalic part is covered with white hairs, which, on the thorax, narrow into bands along the upper edge, not meeting behind. In *capitatus* there are distinct white bands running back from the lateral eyes. The abdomen has a white band high up on the front end and sides, not continuous behind. Below this the brown color is plainly visible. Within the white band is a less distinct blackish band, and, from both, there are projections rising toward the middle, so that on the posterior part of the abdomen there is a succession of white spots barred off with black, on each side. In *capitatus* the white band runs low down on the sides, no brown showing beneath it. The clypeus is brown with a fringe of white hairs. The falces are vertical and brown. The legs are barred with light and dark, and have short white hairs. The

palpus has white hairs on the femur and patella, and a few on the tibia. Our female is in a rather damaged condition. The cephalothorax is covered, on top, with a mixture of white and yellow hairs. The sides have yellow hairs with white bands above, not meeting behind, and there is a white line around the margin. The abdomen has no distinguishable markings when dry, but seems to have been covered by white and yellow hairs. Under alcohol the ground color is white or pale, with three longitudinal dark streaks, the middle one taking something like the herring-bone pattern, while those on the sides run off into oblique markings. The clypeus is covered with long white hairs, and there is a bar of white hairs across the upper part of the face of the falces, which are brown. The legs and palpi are yellow, the legs with short, and the palpi with long white hairs.

We have one male and one female from Cuba.

Dendryphantes Smithii, sp. nov.

Pl. XXVIII, figs. 4–4a.

Length, ♂ 4 mm; ♀ 4.5 mm. Legs, ♂ 1423, ♀ $\overline{14}$ $\overline{32}$, first stoutest.

The cephalothorax is rounded, the widest point being behind the dorsal eyes. The cephalic part is inclined; the thoracic slants very slightly in the first two-thirds, and then drops. The quadrangle of the eyes occupies about half of the cephalothorax. It is wider behind than in front, and is one-third wider than long. The front eyes are rather small, the middle being less than twice the size of the lateral, and touching, while the lateral are a little separated from them. This row is slightly curved. The second row is nearer the first than the third. The third row is nearly as wide as the cephalothorax. Under alcohol the cephalothorax is red brown with two black spots on the eye-region, and the abdomen paler with a dark herring-bone stripe in the female, and three pairs of large dark spots, barred off with white, in the male. When dry the male has the cephalothorax covered with fawn colored hair, and the abdomen with light, iridescent scales, while in the female the cephalothorax has white bands on the upper sides, and the top and lower sides, as well as the abdomen, covered with yellow hairs. The legs and palpi are

yellow with white hairs. The clypeus is brown, but has a fringe of white hairs hanging down over the falces. The falces are brown, those of the male being oblique and divergent, while in the female they are vertical and parallel. The maxillae are twice as long as the lip, and truncated.

Of this species we have a male and female from Chapoda, sent to us by Mr. Herbert H. Smith, for whom we have named it.

Selimus, gen. nov.

Pl. XXVIII, figs. 10–10c.

While this genus shows a great similarity to *Dendryphantes* in its marking and coloration, it is quite distinct from it in the shape of the cephalothorax, which widens out plainly both from the front end backward, and from above, below. The outline is rounded, the cheeks being swollen, and the widest point is at the dorsal eyes, which form a row much narrower than the cephalothorax. The upper surface is nearly flat, there being a slight rounding up toward the dorsal eyes in both directions. The posterior half of the thoracic part falls more steeply. The quadrangle of the eyes is one-fourth wider than long, is a little wider behind than in front, and occupies two-fifths of the cephalothorax. The front eyes are large, in a slightly curved row, the middle being nearly twice as large as the lateral and close together, while the lateral are a little separated from them. In the male the relative length of the legs is 1423, the first being the stoutest and much longer than the others.

Selimus venustus, sp. nov.

Pl. XXVIII, figs. 10–10c.

♂. Length 8.5 mm. Legs 1423, the first stoutest, and exceeding the second by the tarsus, metatarsus, and half of the tibia.

This species looks very much like *Dendryphantes militaris*, but it is larger and differently shaped. The cephalothorax is dark brown with wide white bands, not meeting behind, along the upper sides. Around the lower margin is a black line between two white lines. The abdomen is dark brown with a

metallic luster down the middle of the dorsum, and has a wide silvery white band around the front end and sides, reaching nearly to the spinnerets. The legs are all dark brown without white hairs or scales excepting a small tuft of long, pure white hairs on the inner side of the proximal end of the patella of the first. The palpi, falces, and clypeus are dark brown without conspicuous hairs. The falces are robust and vertical. The maxillae are broad and heavy, three times as long as the lip, and truncated.

We have a single male from Sao Paulo, Brazil, sent to us by Mr. Moenkhaus.

Admirala gen. nov.

Pl. XXVIII, figs. 11–11c.

Rather small, graceful spiders with the first leg longest, stoutest, and darkest.

The cephalothorax is rather long and only moderately high. The sides are not far from parallel but widen a little behind the dorsal eyes. They are a little wider below than above. The upper surface is broad, and has a level look, although there is a slight rounding off in both directions from the dorsal eyes. After the first half the thoracic part falls steeply. The quadrangle of the eyes is one-third wider than long, occupies nearly one-half of the cephalothorax, and is a little wider behind than in front. The anterior eyes are large, in a row which curves downward, and are all close together. The middle eyes are at least twice as large as the lateral. The second row is nearer the first than the third, and the third row is nearly as wide as the cephalothorax at that place. The legs, so far as we know them, are 1423 in both sexes.

Admirala lepida, sp. nov.

Pl. XXVIII, figs. 11–11c.

♂. Length 5.5 mm. Legs 1423, first much the stoutest.

The body is covered with a mixture of white and golden hairs. There is a white line around the margin of the cephalothorax, and the clypeus is covered with white hairs. On the front part of the abdomen are two pairs of white spots. Behind the mid-

dle there is a median band of metallic yellow, and on the sides of this, three pairs of brown spots divided by transverse white bands. The first legs are brown with many white scales. The other legs are yellow with black spines. The palpi are light brown with white hairs. The falces are light brown and vertical. The maxillae are rounded and about twice as long as the lip.

We have one female from Brazil.

Admirala regia, sp. nov.

Pl. XXVIII, figs. 12–12a.

♂. Length 5 mm. Legs 1423. The first is much the darkest, and although not very long, exceeds the second by the tarsus, metatarsus, and nearly all of the tibia. It is plainly the stoutest.

The cephalothorax has purplish metallic scales on top, and, on the upper sides, white bands which do not meet behind. The lower sides are brown. The abdomen is entirely encircled by a white band, and has a median longitudinal band of iridescent scales. Between this and the white, on either side, is a dark brown band, upon which, at the very posterior part, are three blackish spots. The first legs are dark brown with many snow-white scales. The other legs are yellow with black spines. The clypeus is covered with white hairs. The falces are short and nearly vertical; they are wide at the proximal end and narrow at the tip, the fang being short and crescent shaped. In color they are brown. The palpi are brown with some white hairs. The maxillae are truncated and have a slight projection at the outer corner. The lip is as wide as it is long.

We have a single male from Rio Janeiro.

Jotus, L. K.

For illustration of type, see *Arachniden Australiens*, Koch and Keyserling, Pl. CVI, fig. 1–1d.

Of the species described under this genus by its author, we have the type, *auripes, ultimus* and *micropthalmus*. Of these we leave only *auripes* in *Jotus*, using *ultimus* as the type of a new genus, *Vircqua*, and referring *micropthalmus* to a new

genus, *Mollika,* of which the type is *metalescens* L. K. We have also two species, sent to us by Mr. Frost, which are described below.

The spiders are of medium size with the cephalothorax high and convex, the cephalic part being inclined, moderately in *auripes,* and very steeply in *Frostii.* The sides are nearly vertical and parallel in front, but widen out somewhat behind. The quadrangle of the eyes is one-fifth wider than long, and occupies two-fifths of the cephalothorax. It is a little wider in front than behind. The anterior eyes, which are all well separated, form a straight or slightly curved row, and the lateral are more than half as large as the middle eyes. The second row is about halfway between the first and the third, and the third row is as wide as the cephalothorax at that place.

All of our species are from Australia and are represented only by males, two of which, *auripes* and *Frostii,* have the legs and palpi heavily fringed.

Jotus Frostii, sp. nov.

Pl. XXV, fig. 12; Pl. XXVI, figs. 9–9a.

♂. Length 6 mm. Legs $\overline{1432}$. (The male of *auripes* has the relative length of the legs 4312.)

This is a very striking and distinct species, from the shape of the cephalothorax. The dorsum is level through half the thoracic and abouth a fifth of the cephalic part, and from this point the cephalic plate, which is wedge-shaped and highly iridescent, slopes very steeply forward. The sides widen just behind the dorsal eyes, and then narrow again behind. The first row of eyes is straight. The falces are weak, vertical, and light brown in color.

The lower sides of the cephalothorax are reddish brown, with wide snow white bands. The upper sides and the dorsum are dark and iridescent. The clypeus seems to have been covered with white hairs, and the eyes of the first row are of a deep violet color. The abdomen, which under alcohol shows a dark longitudinal central band, with a whitish region on each side, when dry, seems to have been covered with a mixture of white and pale yellow hairs, which form no distinct pattern. The legs

are reddish brown, contrasting with the darker body. All of them have the femur darker colored than the other joints and highly iridescent, and in the first leg it is much thickened. The first leg has, on the femur, a heavy fringe of dark hairs above, and of pure white hairs below. The patella has a short white fringe, and the tibia a longer, scanty one of smoky colored hairs. The palpus has, across the proximal end of the tarsus, a wide, transverse band of pure white hairs. This point alone would serve to easily distinguish this species from *auripes,* in which the palpus has a long fringe of brown hairs on each side.

We have one male, from Victoria, sent to us by Mr. Frost, to whom we are indebted for a large number of Australian Attidae.

Jotus arci pluvii, sp. nov.

Pl. XXV, fig. 16; Pl. XXVI, figs. 5–5a.

♂. Length 6 mm. Legs $\overline{1432}$.

This species has the cephalic part very slightly inclined and the thoracic slopes only very slightly in the first third, and then rather steeply.

The cephalothorax is black, with a band of white hairs around the lower sides. The hairs, above, are mostly rubbed off, but form a scalloped gold-colored band around the eye region, and grow yellow and thick on the face and clypeus. The abdomen is black with two transverse white bands, one near the front end, and one behind the middle, back of which are several transverse white lines. The bands are made of scale-like hairs, which also grow scattered over the dorsum, and in tufts on each side of the spinnerets. The lower part of the front end is black. The legs are pale, excepting on the tibiae and distal ends of the metatarsi of the first and second, which are smoky-colored, with dark hairs, and the distal ends of the femora of the third and fourth, which are dark. The palpi are pale brown.

We have one male from St. Cruz, Australia.

Viroqua gen. nov.

For illustration, see *Arachniden Australiens,* Koch and Keyserling, Plate CVIII, figs. 2–2d.

This genus, while in many ways like *Jotus,* lacks the delicate, graceful appearance of *auripes* and of *Frostii,* being rather heavily formed. The lateral eyes of the first row are more widely separated from the middle eyes and are relatively smaller, being scarcely more than half as large, and they are placed further back. The thoracic part of the cephalothorax looks higher than in *Jotus,* falling, as it does, in a graceful slope from the dorsal eyes for a short distance, and then in a steep slope, while the cephalic part is strongly inclined forward.

The cephalothorax is long, the sides being nearly parallel, but wider below than above, and swollen out in front to form cheeks. The quadrangle of the eyes is one-fifth wider than long, occupies two-fifths of the cephalothorax, and is wider in front than behind. The first row is curved; the second row is about halfway between the first and third; and the dorsal eyes, which are small, form a row not quite so wide as the cephalothorax. The slope of the cephalic part is so steep that the clypeus is very narrow. The legs of the first pair are plainly longer than the others, but are not much stouter.

This genus is founded upon *Jotus ultimus* L. K., of which we have several specimens, both males and females, sent to us by Mr. Frost, from Victoria.

Escambia P., 1896.

Attidae of Central America and Mexico, Occ. Papers Nat. Hist. Soc. of Wisconsin, Vol. III, p. 41, Plate III, figs. 3–3e.

This genus, which is very like *Dynamius,* is found in Central and South America and Mexico. The spiders are of medium size and have the third and fourth pairs of legs not very different, in length and thickness, from the first and second. They are also characterized by iridescence on the cephalothorax and legs.

The cephalothorax is moderately high and convex, and is usually not much wider in one part than in another, although

some of the species (especially *conspecta*) broaden out a little behind the dorsal eyes. The sides are not far from vertical, widening a little from above below; in the cephalic part they are sometimes slightly concave. The cephalic part is plainly inclined forward. The thoracic always falls, although sometimes only slightly, from the dorsal eyes, and in this respect *Escambia* differs from *Dynamius,* in which genus the thoracic part does not fall backward for some distance, although it may round off on the sides. The quadrangle of the eyes is equally wide in front and behind or a little wider in front; it is about one-fourth wider than long, and occupies two-fifths, or a little more, of the cephalothorax. The anterior eyes are rather large and are usually a little separated. They form a straight or very slightly curved row (in *Dynamius* the first row is more distinctly curved), of which the middle eyes are nearly twice as large as the lateral. The second row is halfway between the first and the third. The third row is as wide or nearly as wide as the cephalothorax at that place.

This genus presents some difficulties, as there is a good deal of variation, not only among the different species, but between the two sexes. The males fall more steeply than the females behind the dorsal eyes, and have the sides more rounded out.

We have three old species, *conspecta, alacris,* and *parvula* (described in *Attidae of Central America,* Nat. Hist. Soc. of Wisconsin, 1896), and two new ones which are described below.

Escambia valida, sp. nov.

Pl. XXVI, fig. 6; Pl. XXV, figs. 13–13c.

Length, ♂ 7 mm; ♀ 8 mm. Legs, ♂ and ♀ $\overline{\overline{3421}}$.

This handsome species is the only one that we have from Brazil.

In the male all the legs have a fringe of black hairs on the patella and tibia. This fringe is heaviest on the third pair, where it runs down on to the metatarsus, and is very light and inconspicuous on the fourth. The metallic lustre is most brilliant on the tibia of the first and second pairs. The tarsi are all pale yellow, contrasting with the dark color of the other joints.

In our specimens the cephalothorax, although badly rubbed, shows patches of yellowish white hairs on the cephalic part and behind the dorsal eyes. Hairs of the same color surround the eyes of the first row, while across the lower edge of the clypeus is a row of pure white hairs. The falces have some white hairs on the front surface. The abdomen is brown, with a wide, white, transverse band of scales near the anterior end, another, narrower, just behind the middle, and two pure white spots, one on each side, just above the spinnerets. In some cases there is a slender line of small yellowish chevrons running forward from the spinnerets to the posterior band.

In this species the cephalic part is strongly inclined and the eyes of the first row are large and close together, forming a somewhat curved row.

We have one male and three females from the Amazon.

In general appearance the female of *E. valida* much resembles that of *Dynamius placatus,* but in the former species there are two white dots above the spinnerets, which have the form of bars in *placatus.*

Escambia electa, sp. nov.

Pl. XXVI, figs. 11–11c.

Length, ♂ 6.5 mm.; ♀ 5.5 mm.

Legs, ♂ $\underline{3}4\underline{21}$; ♀ 3412. The first and second pairs are a little the stoutest.

This species is very like *valida,* the male having fringes of black hairs on the first three legs, metallic lustre on the first and second, and all the tarsi pale. In both sexes the cephalic plate has a covering of yellowish scales, while the thoracic part shows patches of white hairs; there are wide white bands on the sides. The rings around the eyes of the first row are distinctly yellowish, but the hairs all over the clypeus and the front faces of the falces are white. Under alcohol the abdomen has a dark background with a white transverse band near the anterior end, and two white horseshoe shaped marks behind, which begin on the dorsum, curve down low on the sides and then bend up again in front of the spinnerets. When the spider is dry, these white

markings change to a pale golden color, and are seen to be formed of scales, while between them the surface of the abdomen is covered with hairs of a rusty red hue.

The anterior eyes, which form a curved row, are not strikingly large, as in *valida*. The cephalic plate is more strongly inclined in the male than in the female.

We have two males and two females from New Grenada.

Dynamius Simon. 1887.

Pl. XXV, figs. 6–6b.

Ann. de la Soc. Ent. de France, *Arachn. de l' Amerique Centrale et des Antilles,* p. 204.

Type, *Jotus opimus* Peckham, Proc. Nat. Hist. Soc. of Wisconsin, 1885, p. 71. The drawing shows the spider as it appears under alcohol, the pattern not coming out distinctly.

This genus is found in Central and South America and the West Indies. The spiders are usually of medium size or a little smaller, with long, rather heavy legs which are not very unequal in length, the most common leg formula being 3412. It is very close to *Escambia.*

The cephalothorax is high, convex, massive, and long. The sides, which slant outward from the upper surface, are nearly parallel until just in front of the posterior border in the type, and are always widest behind the dorsal eyes. The males have a cheek-like swelling in front. The cephalic part is strongly inclined. The thoracic never falls directly from the dorsal eyes, some species having a short rounded thoracic plate, while others are flat for a considerable distance.

The quadrangle of the eyes is only about one-fourth wider than long, is equally wide in front and behind or a little wider in front, and occupies barely two-fifths of the cephalothorax. The eyes of the first row are large and form a curved line. In *opimus* they are all well separated but in the other species they are near together. The middle eyes are plainly less than twice as large as the lateral. The second row is variable in position. The third row is narrower than the cephalothorax at that place.

Of this genus we have in our collection *opimus,* the type, from

Guatemala, *metallicus* P., from St. Vincent, and five new species described below. M. Simon writes to us that he has more than fifteen species from Brazil.

Dynamius is distinguished from *Escambia* by having the first row of eyes plainly curved, with the lateral eyes of the first row larger, relatively to the middle eyes; and by the shape of the thoracic part, which, in *Escambia,* falls more or less steeply from the dorsal eyes. *Jotus,* which it also resembles, is found only in Australia. From *Philaeus* it is easily distinguished by the greater relative length of the third and fourth pairs of legs.

In all our species of *Dynamius* there is a metallic lustre on the integument of the cephalothorax (even where this is covered with scales or hairs), and, to a greater or less extent, on all the joints of all the legs, especially on the tibiae and metatarsi of the first and second pairs. This lustre is also found in *Escambia.*

The color and marking of the different species are very similar, consisting of white transverse banding on a dark background.

Dynamius blandus, sp. nov.

Pl. XXVI, fig. 1; Pl. XXV, figs. 9–9b.

Length ♂ 6.5 ♀ 8 mm; ♀ 10 mm.

Legs, ♂ $\underline{\overline{3}4\overline{2}1}$, ♀ $\underline{\overline{3}41\overline{2}}$, first, second, and third, a little the stoutest.

The cephalothorax seems to have been covered with a mixture of white and yellowish hairs. Around the eyes of the first row and on the cheeks and clypeus are red hairs. There are white bands around the sides. The abdomen is dark colored in the male but in the female is sometimes brown flecked with white. The markings are formed by scales and are white or yellowish. They consist of a band on the anterior part, of a wide transverse band behind the middle, and of a pair of spots at the posterior end. Behind the band is a dark region which is divided into two parts by a slender line of tiny white chevrons running forward from the spinnerets. The first, second, and third pairs of legs have slight fringes of dark hairs on the inner and outer sides. The palpus has white hairs on the femur and

patella. The falces are vertical and rather stout, with a few white hairs or bristles. The quadrangle of the eyes is widest in front, and the second row is half way between the first and the third.

We have numerous examples from Port of Spain, Trinidad, sent to us by Mr. Broadway.

In distinguishing *blandus* from *placatus*, we notice that in *placatus* the first and second legs are relatively shorter. In *placatus* the third leg is longer than the second by the tarsus and nearly all of the metatarsus, while in *blandus* it is longer by scarcely more than the tarsus.

Dynamius placatus, sp. nov.

Pl. XXV, figs. 11–11c; Pl. XXVI, fig. 1.

Length, ♂ 6–7 mm; ♀ 7–8 mm.

Legs, ♂ 3412, ♀ 3412, first and second plainly the stoutest.

Our specimens have suffered much from rubbing. The cephalic part is dark and iridescent; the thoracic lighter, reddish brown, with white bands around the sides. There are some patches of light golden scales. On the clypeus and cheeks and around the eyes of the first row are bright red hairs, the clypeus having white hairs on the lower edge. The small vertical falces have white bristles on the front surface.

The ground color of the abdomen is black, and the markings vary from white to light golden, and are formed by scales. On the anterior part are two irregular spots, sometimes united to form a band; behind the middle is a wide transverse band, in which is sometimes seen a small dark triangular spot; above the spinnerets are two small spots, the inner sides of which touch a slender central line which runs forward to the transverse band mentioned before. This often gives a distinctly anchor-shaped figure. The whole abdomen is thinly clothed with long, coarse, white hairs.

The legs are reddish brown, paler toward the ends. In the male the tibial joint of the first and second legs shows beautiful, iridescent, violet reflections, which are also found less distinctly on the patella, and there are two fringes of black hairs, one on the outer and one on the inner side of the tibia and metatarsus of the first and second legs.

The second row of eyes is halfway between the first and the third, and the quadrangle is equally wide in front and behind. The thoracic part, while it does not slant backward for some distance behind the dorsal eyes, rounds off on the sides.

We have two males and several females, sent to us from Trinidad, by Mr. Broadway.

Dynamius fimbriatus, sp. nov.

Pl. XXV, figs. 10–10a; Pl. XXVI, fig. 12.

♂. Length, 7 mm. Legs 3$\overline{421}$.

This handsome spider has a heavy fringe of black hairs along the front sides of all the legs, especially heavy on those of the second pair. The first and second legs are enlarged, and have the tibia and the distal end of the patella, brightly iridescent. The integument of the cephalothorax is iridescent, the cephalic part being black and the thoracic brown. There are wide white bands on the sides, and the upper surface was probably covered with yellowish scales of which a few patches remain. Around the eyes are rings of reddish hairs. The falces are brown, slightly iridescent, vertical, and moderately stout, with little white bristles on the front face. The abdomen seems to have been covered with yellowish white scales. Under alcohol it appears whitish, with a wide transverse brown band in front of the middle, and two large brown spots on the posterior part. There is a long flat thoracic plate and the first row of eyes is distinctly curved. The quadrangle of the eyes is wider in front than behind, and the second row is a little nearer the first than the third.

The fringes on the legs serve to distinguish this species. We have two males from Chapoda, Brazil, in the Smith collection.

Dynamius parvus, sp. nov.

Pl. XXV, figs. 14–14c; Pl. XXVI, fig. 8.

Length, ♂ 7mm; ♀ 6 mm.

Legs ♂ 1$\overline{324}$; ♀ 3$\overline{412}$; all rather slender. In the female the first and second are much shorter than the third and fourth.

We have a good many specimens of this species but all have suffered more or less from rubbing. Under alcohol they show

a dark colored cephalothorax with a white band just behind the first row of eyes, another, shorter and somewhat crescent-shaped, behind the third row, and wide white bands on the sides, which run forward and curve around in front of the dorsal eyes. The markings on the abdomen are less constant, although the general impression is of a dark background transversely banded with white. In some cases the anterior and posterior ends are dark beyond the white bands. The central white band is behind the middle of the abdomen. The sides are entirely white and a slender, central, longitudinal white line, which is often indistinct, runs over the dorsum throughout its length. In many specimens the white regions at the anterior and posterior ends are indistinct, and the central white band has a small dark triangular spot in the middle. In some cases the abdomen might be described as white with two dark transverse bands. There are no fringes on the legs.

When dry, the more perfect specimens show the cephalic part covered with snow white hairs, while bright red hairs grow on the clypeus and cheeks and around the middle eyes of the first row, the clypeus having an edge of white hairs. The small, vertical, iridescent falces have some short white bristles on the front surface. The palpus has snow white hairs on the femur and patella. The same joints on the first leg are of a beautifully metallic steel blue color. The abdomen is jet black with a transverse white band near, but not at, the anterior end, and another behind the middle, and a patch of white just above the spinnerets. In some specimens the black parts are covered with yellow hairs. In one male the hairs on the abdomen and the top of the cephalothorax, instead of being white, are of the soft yellowish color known as "old gold."

In this species the quadrangle of the eyes is plainly wider in front than behind, and the eyes of the second row are very slightly nearer the third than the first row.

We have two males and numerous females from Brazil, collected by Mr. H. H. Smith.

Dynamius gratus, sp. nov.

Pl. XXV, figs. 8–8a; Pl. XXVI, fig. 10.

Length ♂ 5—5.5 mm. Legs, $\overline{3}421$.

This species is rather small for *Dynamius.* Looking at it under alcohol it has a long black cephalothorax, with wide white bands on the sides, and a short dark abdomen, with three transverse white bands, one in front, one behind, and one across the middle. All the legs are iridescent, especially the first, on the tibia and patella, but they have no heavy fringes. The thoracic part is flat for some distance behind the dorsal eyes. The eyes of the second row are halfway between the lateral and the dorsal eyes.

When the spider is dry, bright red hairs appear around the eyes of the first row, and all over the clypeus, excepting a narrow white line at the margin. We also find a few patches of white hairs left on the black cephalic part. The front part of the abdomen is occupied by a band of white hairs, behind which are some yellowish hairs, and behind this again, is a region that is jet black. Across the middle is a wide white band, then more yellowish hairs, and then an indistinct band of white hairs. The falces are small, brown, vertical, with a few white bristles.

So far as coloring is concerned it is difficult to distinguish this species from *parvus.* In both species the cephalic part is very slightly inclined, but while in *gratus* the flat portion of the thorax occupies four-fifths of its length, in *parvus* it occupies only about one-half. The relative length of legs is different, and while the white hairs on the femur of the palpus are long in *parvus,* they are short in *gratus.*

Linus P., 1885.

Pl. XXV, figs. 5–5b.

The cephalothorax is very high, with the sides almost vertical and parallel. It falls sharply in both directions from the highest point, at the dorsal eyes. The quadrangle of the eyes is one-fourth wider than long, is wider in front than behind, and occupies one-half of the cephalothorax. The first row, which is

curved downward, has the eyes all subtouching, the middle ones projecting and very large, two-and-a-half times as large as the lateral. The eyes of the second row are also unusually large, and are halfway between the first and third rows. The third row is nearly as wide as the cephalothorax, which is a little wider here than at any other point. The relative length of the legs is 4123, all long and slender, particularly the metatarsi and tarsi. The abdomen, above and below, and some joints of the legs, have bunches of short stout hairs scattered over the surface.

This genus was founded by Thorell, in 1878, on *fimbriatus* Dol., under the name *Sinus*. This being preoccupied, *Linus* was substituted in 1885 (*Genera of Attidae,* p. 289).

We have the type, and *africanus* Simon, from Natal. Thorell has described *subvexus* from Sumatra and *labiatus* from Burmah under this genus.

Maevia (C. K.) 1848.

Pl. XXV, figs. 7–7b.

The cephalothorax is moderately high and is but little longer than wide, the sides being nearly vertical and parallel in the cephalic part, and bulging out behind the dorsal eyes. The cephalic part is inclined, but the thoracic does not slope backward in the first half, although it rounds off on the sides. (In *coronigera* the thoracic part falls from the dorsal eyes.) The eyes of the first row are large, and are subtouching or a little separated, the middle ones being about twice as large as the lateral. They form a straight or slightly curved row. The second row of eyes is halfway between the first and the third or a little nearer the first. The third row is nearly as wide as the cephalothorax at that place. The quadrangle of the eyes is from one-fourth to one-third wider than long, is equally wide in front and behind or a little wider in front, and occupies two-fifths of the cephalothorax. The legs in the males are 4132, or 41$\overline{23}$, and in the females, 43$\overline{12}$, 41$\overline{32}$ or $\overline{34}$$\overline{12}$.

This genus was made by C. Koch in 1848, the first species described under the name being *pencillata* (which is a synonym of *Attus vittatus* and *Attus niger* Hentz), and we therefore take

this as the type. In a recent letter M. Simon agrees to this procedure, although he formerly used the name in a different sense. Thorell bases his idea of *Maevia* upon a species described by C. Koch under *Plexippus*. The type, then, is *M. vittata* Hentz.

We have three species, *vittata* H. and *trilineata* new, which resemble each other closely, from the United States, and (*Euophrys*) *coronigera* C. K., (which differs from the other two in the sloping thoracic part), from Guatemala, Trinidad and Cayenne. We take out of this genus *californica* P., *pavesii* Simon, and *tenuis, fenestrata* and *Stolzmanii* Tacz.

Maevia Poultonii, sp. nov.

Pl. XXV, figs. 15–15b; Pl. XXVI, fig. 3.

Medium sized spiders, plainly marked with three bright red lines down the abdomen, between which the color is silvery.

♂. Length 7 mm.

♀. Length 9.5 mm.

Legs in both sexes $\overline{4}132$, not very unequal, the first and second a little the stoutest.

In the male the cephalothorax is covered with white hairs above, and has a white line around the margin. The sides are rubbed, but seem to have been dark colored. Under alcohol it appears black except on the back of the thoracic part. In the female the general color is light, only the eye-region appearing black under alcohol. When dry the whole cephalothorax is seen to be covered with pale hairs. The abdomen, in both sexes, is silvery, with three longitudinal, bright red lines. These are continuous in the female, but in the male they are more or less broken by silvery bars, especially those on the sides, which form four or five elongated spots. The falces are short and vertical, and both face and falces are dark colored. The legs are yellow and very spiny.

We have two males and one female from San Antonio, Texas, sent to us by Mr. C. Tyler Townsend.

Opisthoncus L. K., 1880.

For illustration see *Arachniden Australiens,* Koch and Keyserling, Pl. CII, figs. 5–6.

Medium sized spiders.

The cephalothorax is not very high and is only a little longer than wide. It is highest and widest at the dorsal eyes, the upper surface being lightly rounded, while the outline of the sides is narrowed in curving lines, both in front and behind. The quadrangle of the eyes is from one-third wider than long to about twice as wide as long, is from a very little, to plainly, wider behind, and occupies two-fifths of the cephalothorax. The first row of eyes is straight or a little curved; the middle eyes are twice or nearly twice as large as the lateral, and are close together, the lateral being a little separated from them. The second row is from a little to very much nearer the first than the third. The third row is not so wide as the cephalothorax at that place. The relative length of the legs in the males is 1243, or 1423, and in the females, 1243 or 1423, the first being longest and stoutest and the others not very unequal.

The type of *Opisthoncus* is *lineativentris* L. K., (*Arachn. Australiens,* p. 1184). This species is not in our collection, but we have *polyphemus* L. K., *alborufescens* L. K., *pallidens* L. K., *abnormis* L. K., *bitaeniatus* L. K., *parcedentatus* Rainbow, and a new species, *verisimilis,* described below. Of these *abnormis* is a small species with the first row of eyes bent downward, with the quadrangle very slightly wider behind, and with the cephalothorax higher and less widened than it should be for this genus. *Bitaeniatus* is also a poor *Opisthoncus,* approaching *Simaetha* in having the lateral eyes of the first row very widely separated from the middle eyes. These species are all from Australia.

For convenience in distinguishing the species of *Opisthoncus* we give the following notes.

In *alborufescens* ♂ the first row of eyes is straight; middle eyes less than twice lateral; quadrangle one-third wider than long, and plainly wider behind. In *pallidens* ♀ the relative length of the legs is 1423; first row straight; middle nearly twice lateral; quadrangle nearly twice as wide as long, and a little wider behind. In *parcedentatus* ♂ the legs are 1423;

first row straight; middle about twice lateral; quadrangle nearly twice as wide as long and plainly wider behind. In *abnormis* ♀ the first row is bent downward, the eyes are small, the middle being less than twice the lateral; quadrangle one-third wider than long, and very slightly wider behind. In *bitaeniatus* ♀ the first row is bent downward; middle eyes are twice lateral, and separated from each other; lateral separated from middle by nearly their own diameter; second row twice as far from third as from first; quadrangle about twice as wide as long, and a little wider behind.

Opisthoncus verisimilis, sp. nov.

♂. Length 6 mm. Legs 1243 first and second a little the stoutest.

In this species the anterior eyes are rather large, and form a straight row, the middle ones being nearly twice as large as the lateral, and more separated from them than from each other. The quadrangle of the eyes is nearly twice as wide as long, and is very slightly wider behind.

Under alcohol the cephalothorax is reddish with a dark eye-region. The abdomen is pale brown with a white region down the middle, which is covered with a network of brown lines, and has, on the front part, a brown cross. On the sides of this pale region, behind the middle, are two pairs of dark spots. The legs are brown, the femoral joints being darkest. The palpi are pale brown, long, and delicate. Our specimens are badly rubbed, but when dry they still show a few hairs, which are iridescent on the eye-region and on the sides of the upper surface of the abdomen, and white on the thoracic region and on the lower sides and middle of the abdomen. The clypeus is edged with white. The falces are brown in color and are stout, rounded, obliquely directed forward, and divergent, with a long fang.

We have two males from Victoria, sent to us by Mr. Frost.

PLATE XXIII.

EXPLANATION OF PLATE XXIII.

Fig. 1. Phidippus morsitans, female; 1a, face view; 1b, side view of cephalothorax.

Fig. 2, Phidippus (Megatimus) severus, female; 2a, face view; 2b, side of cephalothorax.

Fig. 3, Phidippus californicus, male; 3a, palpus.

Fig. 4, Phidippus variegatus, male.

Fig. 5, Phidippus Howardii, male.

Fig. 6, Phidippus bardus, female; 6a, epigynum.

Fig. 7, Phidippus ardens, female; 7a, epigynum.

Fig. 8, Phidippus comatus, male, × 6; 8a, palpus; 8b, female, × 6; 8c, epigynum.

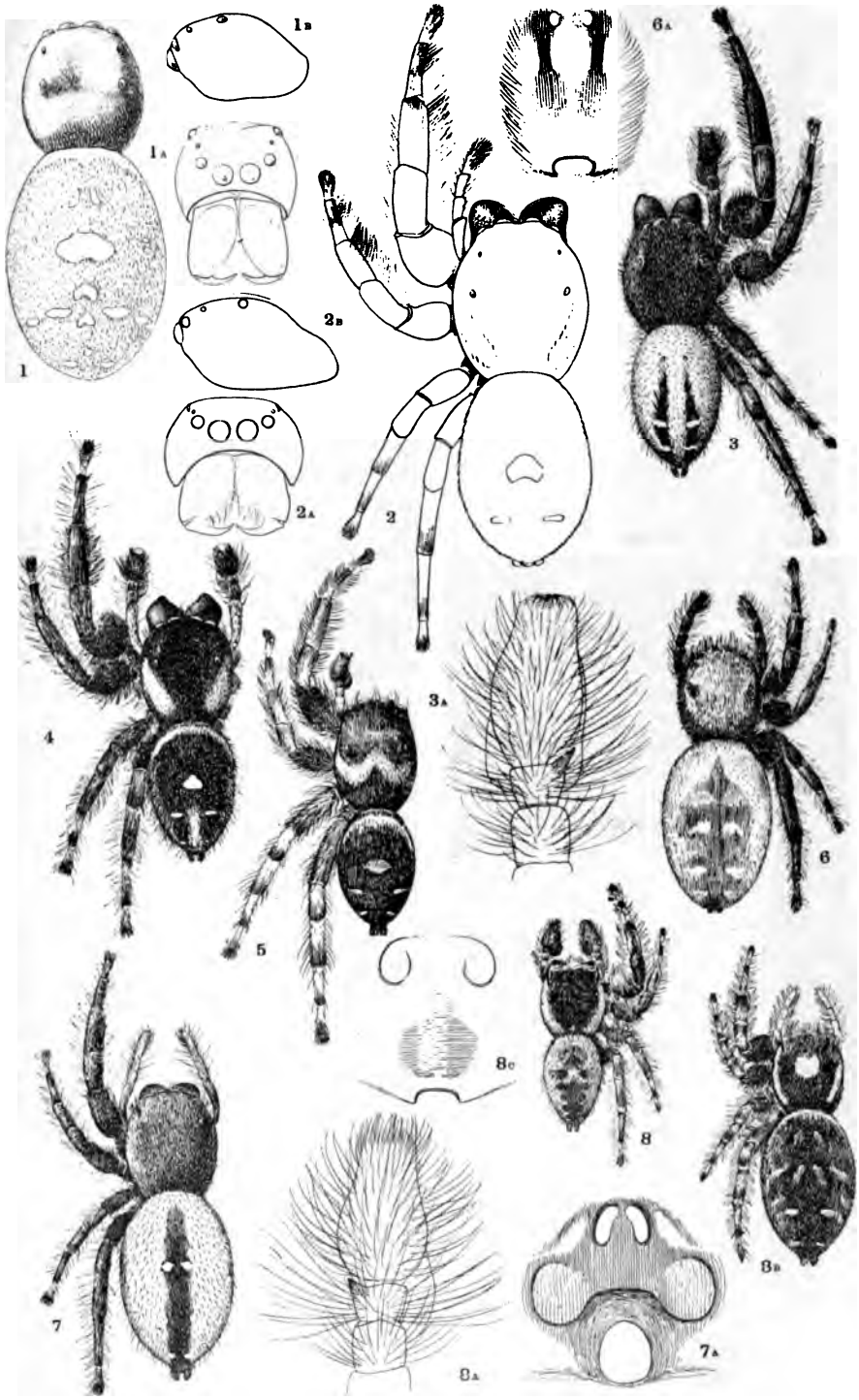
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PLATE XXIV.

EXPLANATION OF PLATE XXIV.

Fig. 1, Phidippus incertus, female, × 6; 1a, epigynum.

Fig. 2, Phidippus obscurus, male, × 6; 2a, female, × 6; 2b, epigynum; 2c, palpus; 2d, face view of male; 2e, of female.

Fig. 3, Phidippus montivagus, female, × 6; 3a, epigynum.

Fig. 4, Phidippus Tyrelli, male, × 6.

Fig. 5, Phidippus Workmanii, female, × 6; 5a, epigynum.

Fig. 6, Phidippus Rauterbergii, female, × 6; 6a, epigynum.

Fig. 7, Philaeus chrysops, female, × 6; 7a, side view of cephalothorax of male; 7b, of female; 7c, face view of female.

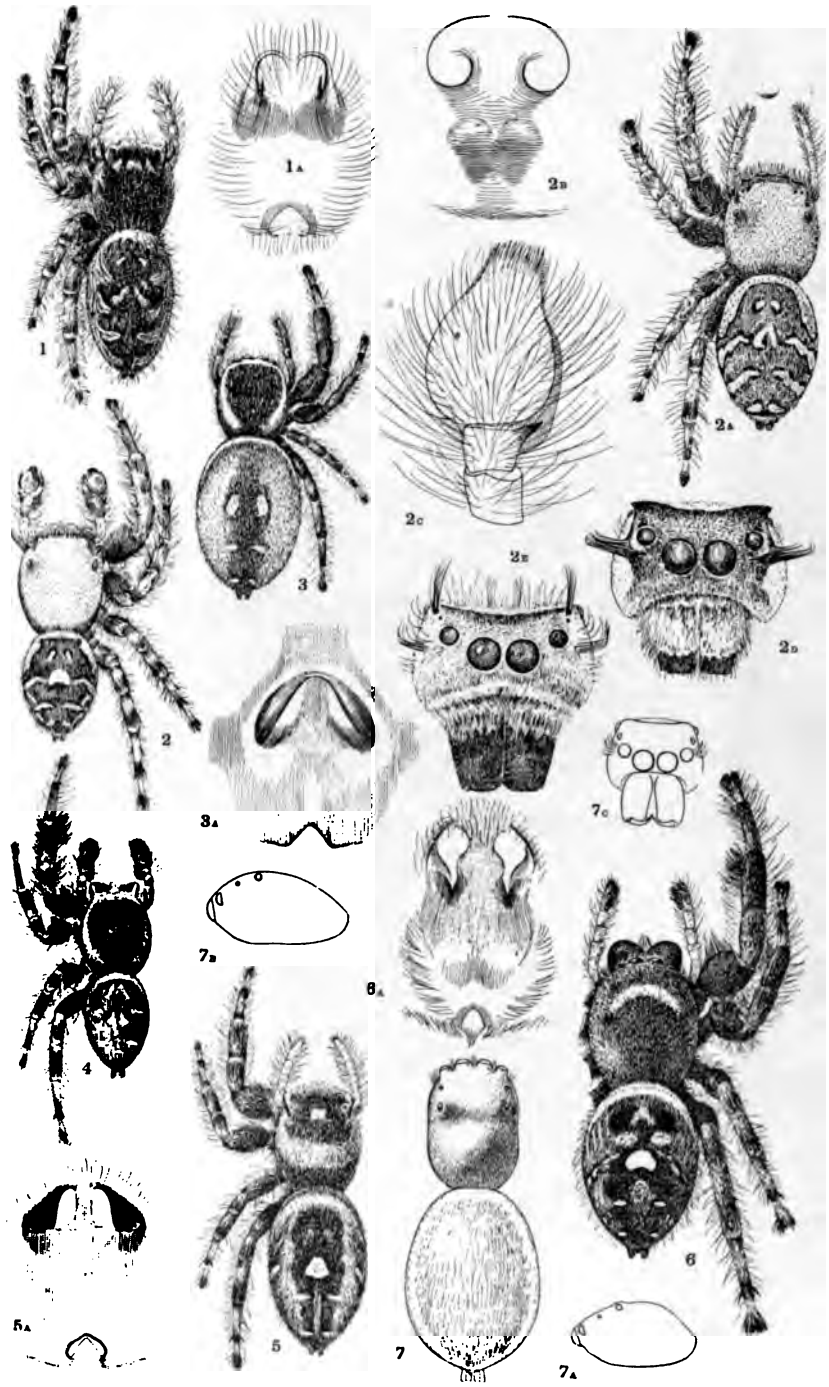
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PLATE XXV.

EXPLANATION OF PLATE XXV.

Fig. 1, Zenodorus d'Urvillei, female, × 6; 1a, male, × 6; 1b, side view of cephalothorax of male; 1c, of female; 1d, face view of male; 1e, of female.

Fig. 2, Servaea vestita, female, × 8; 2a, side view of cephalothorax; 2b, face view.

Fig. 3, Simaetha paetula; 3a, face view; 3b, side view of cephalothorax.

Fig. 4, Thyene imperialis; 4a, face view; 4b, side view of cephalothorax.

Fig. 5, Linus fimbriatus, female; 5a, face view; 5b, side view of cephalothorax.

Fig. 6, Dynamius opimus, female; 6a, face view; 6b, side of cephalothorax.

Fig. 7, Maevia vittata, female, × 8; 7a, face view; 7b, side of cephalothorax.

Figs. 8 and 8a, Dynamius gratus, two views of male palpus.

Fig. 9, Dynamius blandus, epigynum; 9a, 9b, male palpus.

Fig. 10, 10a, Dynamius fimbriatus, male palpus.

Fig. 11, Dynamius placatus, epigynum; 11a, 11b, 11c, male palpus.

Fig. 12, Jotus Frostii, male palpus.

Fig. 13, Escambia valida, epigynum; 13a, 13b, 13c, male palpus.

Fig. 14, Dynamius parvus, epigynum; 14a, 14b, 14c, male palpus.

Fig. 15, Maevia Poultonii, epigynum; 15a, 15b, male palpus.

Fig. 16, Jotus arci pluvii, male palpus.

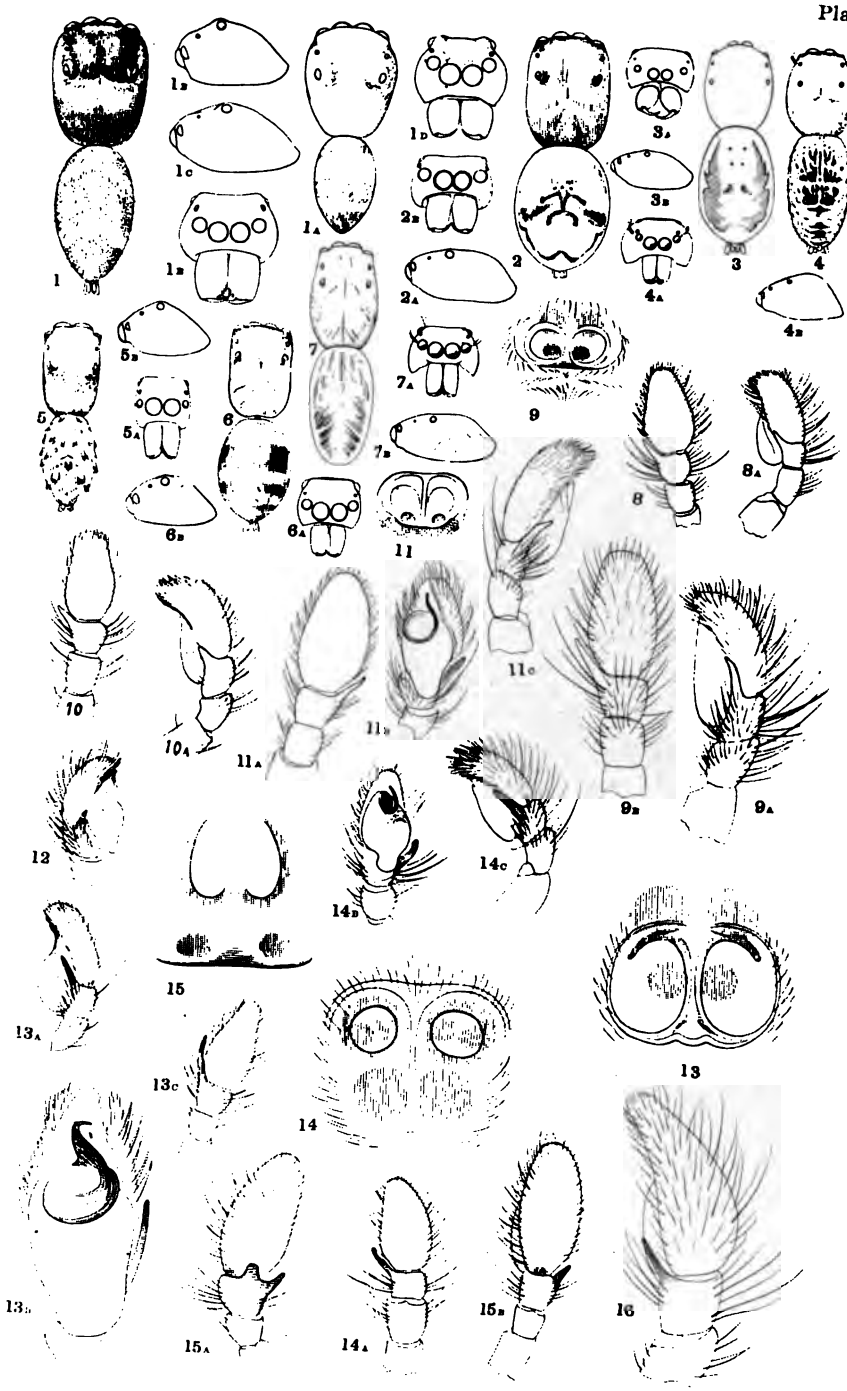
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PLATE XXVI.

PLATE XXVI.

EXPLANATION OF PLATE XXVI.

Fig. 1, Dynamius blandus, male, × 16.

Fig. 2, Dynamius placatus, female, × 16.

Fig. 3, Maevia Poultonii, female, × 16.

Fig. 4, Palestrina variegata, female, × 16; 4a, face view; 4b, side of cephalothorax; 4c, epigynum.

Fig. 5, Jotus arci pluvii, male, × 16; 5a, palpus.

Fig 6, Escambia valida, female, × 16.

Fig. 7, Parnaenus (?) griseus, male, × 15; 7a, 7b, palpus.

Fig. 8, Dynamius parvus, male, × 16.

Fig. 9, Jotus Frostii, male, × 16; 9a, palpus.

Fig. 10, Dynamius gratus, male, × 16.

Fig. 11, Escambia electa, female, × 16; 11a, epigynum; 11b, 11c, male palpus.

Fig. 12, Dynamius fimbriatus, male, × 16. The fringes on the legs are heavier than they appear in the figure.

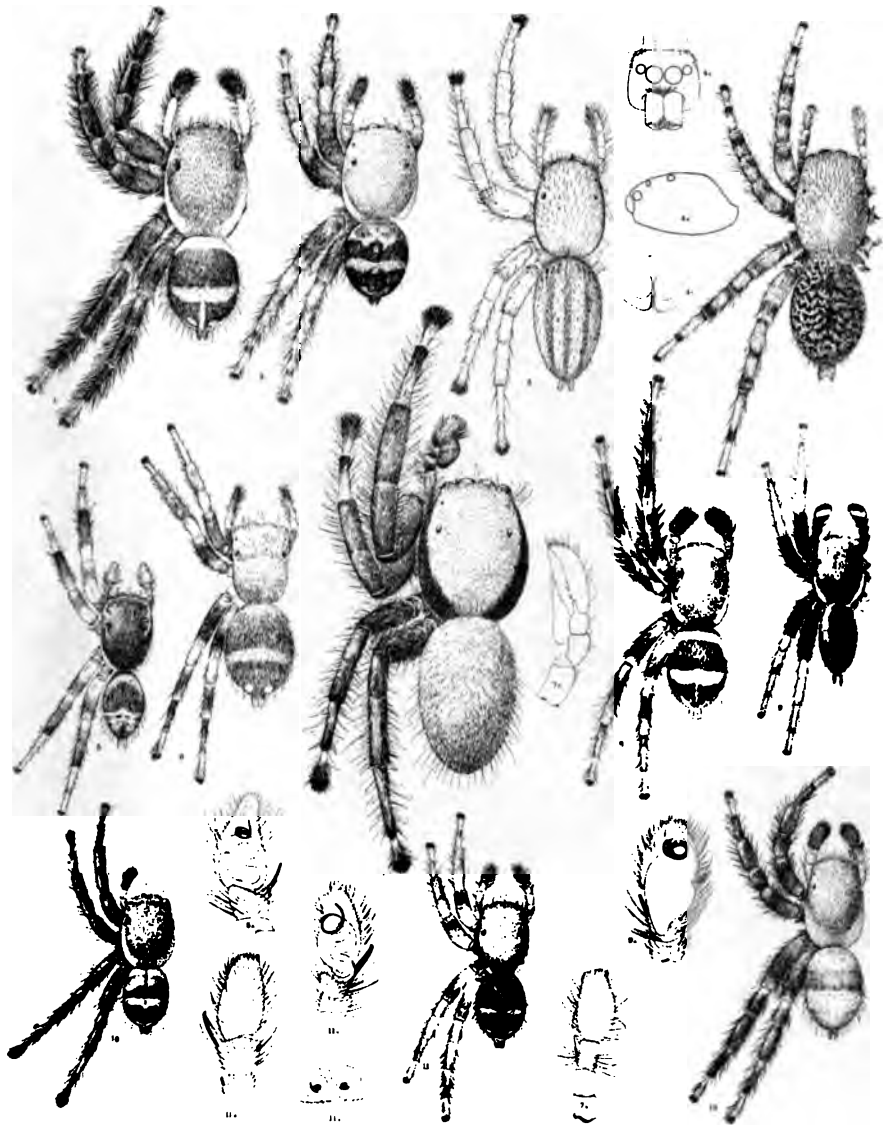

PLATE XXVII.

EXPLANATION OF PLATE XXVII.

Fig. 1, Dendryphantes faustus, face of male; 1a, palpus; 1b, epigynum.
Fig. 2, Dendryphantes albopilosus, male; 2a, female; 2b, epigynum; 2c, palpus.
Fig. 3, Dendryphantes vigens, palpus.
Fig. 4, Dendryphantes perfectus, male; 4a, palpus.
Fig. 5, Dendryphantes prosper, male; 5a, palpus.
Fig. 6, Dendryphantes felix, male; 6a, palpus.
Fig. 7, Dendryphantes cuprinus, epigynum.
Fig. 8, Dendryphantes tropicus, palpus; 8a, falces and maxillae of male, from below; 8b, epigynum.

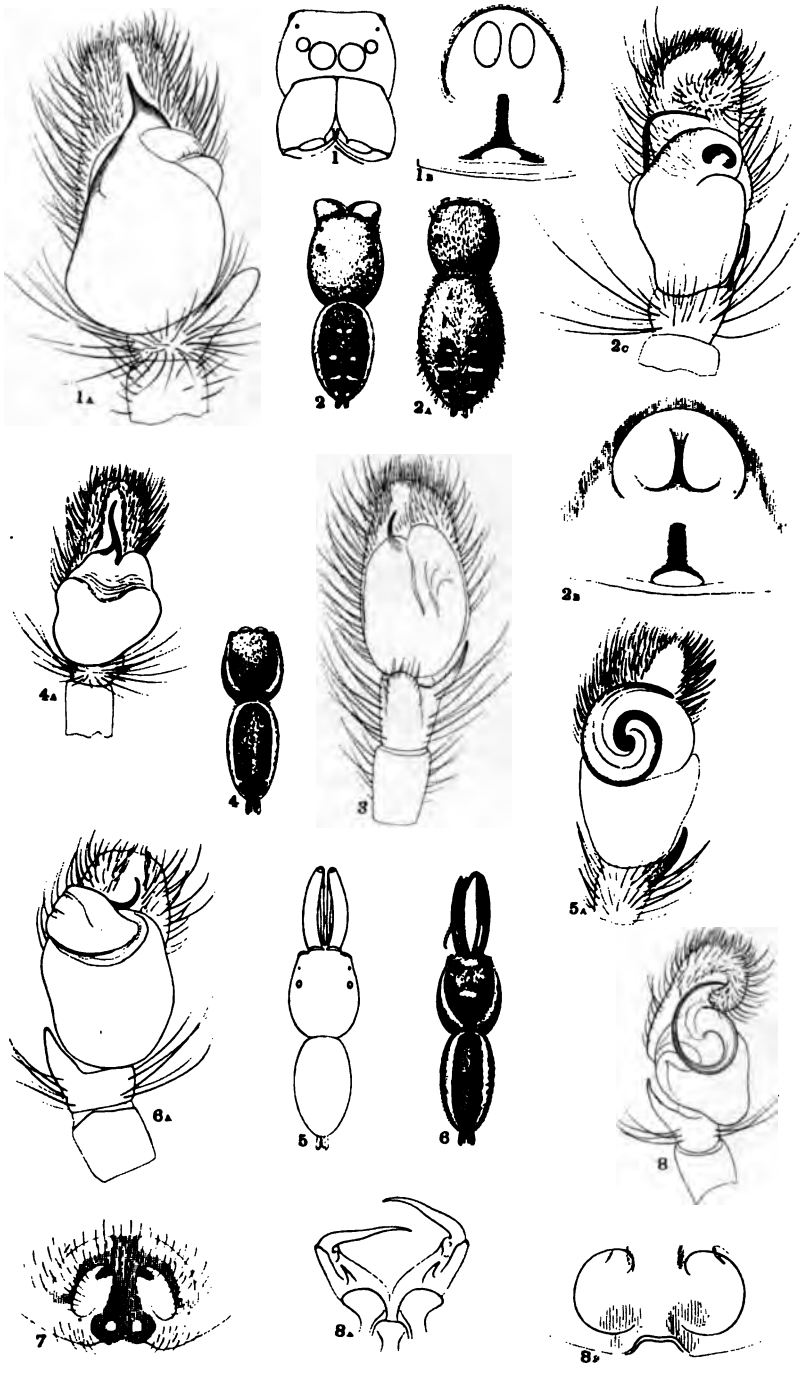
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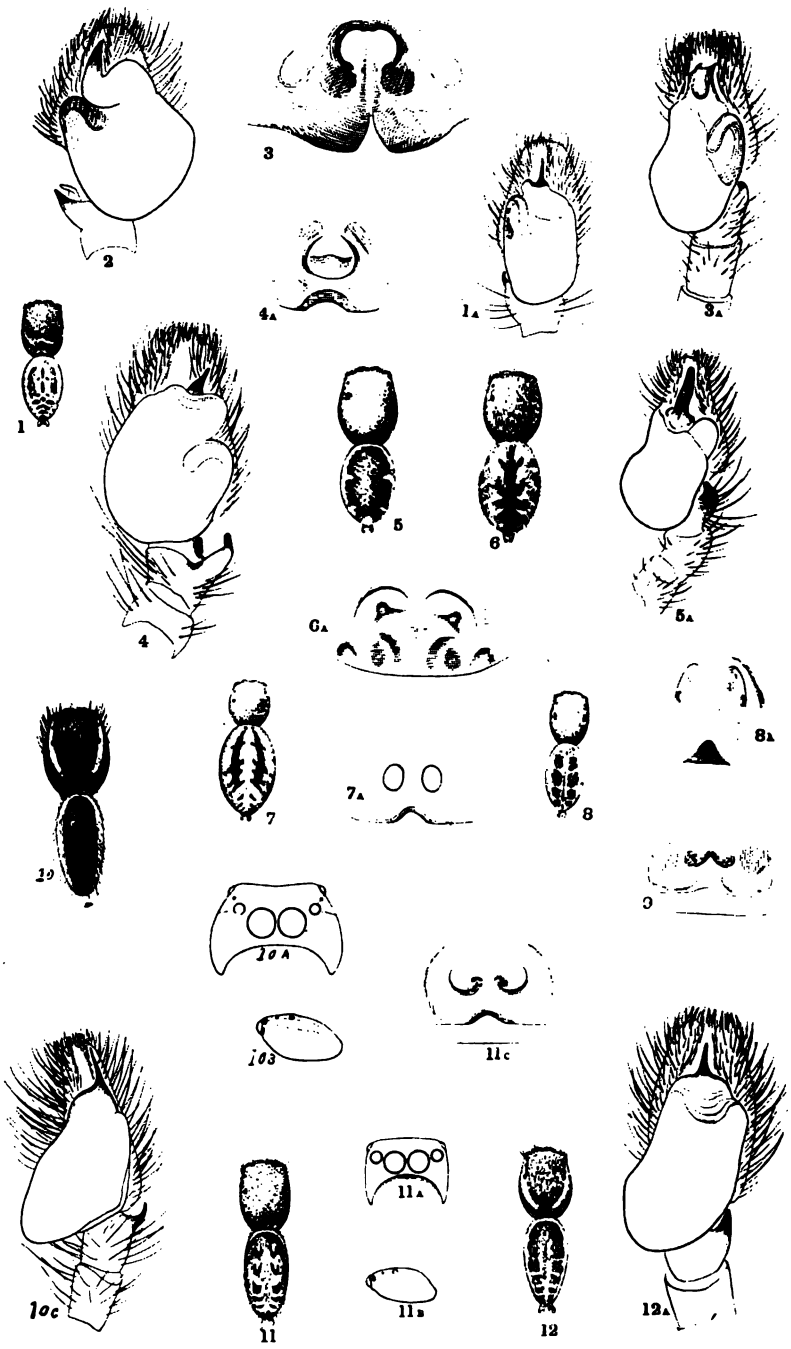
PLATE XXVIII.

EXPLANATION OF PLATE XXVIII.

Fig. 1, Dendryphantes Manii, male; 1a, palpus.
Fig. 2, Dendryphantes arizonensis, palpus.
Fig. 3, Dendryphantes proxima, epigynum; 3a, palpus.
Fig. 4, Dendryphantes Smithii, palpus; 4a, epigynum.
Fig. 5, Dendryphantes pernix, male; 5a, palpus.
Fig. 6, Dendryphantes odiosus, female, 6a, epigynum.
Fig. 7, Dendryphantes vegetus, female; 7a, epigynum.
Fig. 8, Dendryphantes fortunatus, female; 8a, epigynum.
Fig. 9, Simaetha severa epigynum.
Fig. 10, Sidimus venustus, male; 10a, face; 10b, side of cephalothorax; 10c, palpus.
Fig. 11, Admirala lepida, female; 11a, face, 11b, side of cephalothorax; 11c, epigynum.
Fig. 12, Admirala regia, male; 12a, palpus.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ON THE DETERMINATION OF CHLORINE IN NATURAL WATERS, ITS ACCURACY AND SIGNIFICANCE.

ERASTUS G. SMITH, PH. D.,

Professor of Chemistry, Beloit College.

The determination of chlorine is one of the most familiar to students of chemistry. The great accuracy possible in the manipulations due to the practical insolubility of the chloride of silver, the simplicity of the reactions, and the general principles illustrated recommend this determination to teachers of the science as a first problem to set for the student commencing the study of quantitative analytical chemistry. There are three methods for estimating chlorine commonly used in the quantitative laboratory:

1.) The gravimetric method, where the chlorine is precipitated with silver and weighed directly as the chloride.
2.) The volumetric methods:
   a.) With standard silver nitrate using potassium chromate as an indicator. (Mohr's method.)
   b.) With silver nitrate and potassium thiocyanate using ferric chloride as an indicator. (Volhard's method.)

All of these methods are in general use, the analyst exercising his judgment as to which one to employ in any given case.

In the analysis of natural waters, however, the conditions met with in an ordinary analysis are materially changed. Chlorine, whatever the combination, is in small amount; whatever method therefore is used for its determination, it must be one where the exactness of the results obtained is above question. In an ordinary analysis of a chloride, e. g., a milligram error in weighing up the material or the final precipitates would influence the results in the calculations but slightly, so considerable are the

quantities usually taken for the analysis, and the amounts finally weighed up. Only the most painstaking conduct of a chlorine determination could keep the errors liable to arise during the process of the analysis within one milligram. Many of our good natural waters, however, carry less than one part of chlorine to the million of water; take Lake Superior water, e. g., with 1.2 parts off-shore, and less than one part some distance out in the lake; or the waters from some of the natural streams from the upper part of this state above the region of the limestones, as from the Wisconsin or the Chippewa Rivers, with chlorine generally less than one part to the million, or less than one milligram of chlorine to the kilogram of water. Such minute quantities require the most careful manipulation to insure the required accuracy.

Water analysts as a rule have adopted Mohr's method, viz.: the silver method, using potassium chromate as the indicator. This method is convenient, is easily applied, and has much to recommend its wide use at the present time. The details of the manipulations as ordinarily applied are known to all analysts. There are, however, some errors possible in the application of this method which can seriously affect the results obtained. The thought that out of an experience with waters from various sources and of different characters. I might make some suggestion to those having to do with this class of analytical work and thus assist them to reduce, if not wholly to eliminate the errors so apt to creep in despite all care, prompted this brief paper.

Prominent among such difficulties are:

1.) The indefiniteness of the statements concerning the preparation and proving of the standard solutions employed and the details of manipulation of the processes, even in our best works on the subject; to such works, all, whether teacher or student, must refer, and unless one has had a considerable experience or unusually good laboratory instruction, the description of methods is liable to mislead.

2.) The ability of the analyst to recognize colors; and in particular to discriminate between a *yellow* and a *reddish-yellow* and thus to define sharply the end-reaction.

3.) The amount of standard solution necessary to strike the reddish-yellow color, and thus determine definitely the end-reaction.

These are real difficulties, and are of importance, each in its own way, in estimating the small amount of chlorine in normal natural waters. To meet and reduce the errors of observation thus introduced, and in general to make the chlorine determination more exact the following method has been adopted at this laboratory:

A. Apparatus required.

1.) A long thin 10 c. c. Greiner Zero burette graduated to 1-10 c. c.

2.) Three white porcelain dishes uniform in *color*, shape and depth, and of a capacity of a little over 100 c. c.

B. Solutions required.

1.) Standard silver nitrate. The solution to be of such strength that each c. c. will precipitate exactly one milligram of chlorine, i. e., 1 c. c. = 0.001 Cl.

Made by dissolving 4.8022 grams pure silver nitrate in water. Take a clean, smooth, porcelain crucible, ignite thoroughly and weigh. In the crucible place something over 5 grams of crystals of pure silver nitrate and fuse over a Bunsen flame turned so low that the flame *does not play on the wall of the crucible above the salt.* The crystals should melt to a white clear mass without any trace of decomposition along the wall of the crucible. Allow to cool and weigh accurately. The amount of water in which this is to be dissolved can be conveniently reckoned as follows:

4.8022 : wt. silver nitrate actually taken :: 1000 c. c. : vol. water required.

The fused silver nitrate is dissolved in some cold chlorine-free water prepared by redistillation with silver nitrate as given below under note and made up to above calculated volume. Prepared in this manner the solution is very accurate but as a precaution the work should be confirmed by titration against the standard sodium chloride solution prepared below.

From this solution one-half or one-tenth strength standard solutions are easily prepared by proper dilution with chlorine-free water.

2.) Standard solution of sodium chloride. Any arbitrary amount may be taken but it is well to make it of such strength that each c. c. equals one m. g. chlorine. Use c. p. sodium chloride recrystallized from chlorine-free water, dried and gently heated. This solution carefully prepared serves the double purpose of checking the standard silver nitrate solution and for preparing the standard color sometimes needed for high chlorine waters, as below.

3.) A solution of c. p. neutral potassium chromate. Made by dissolving two grams of c. p. chlorine-free salt in 100 c. c. water.

Note: In the preparation of all of the above solutions a water should be used which has been redistilled with silver nitrate. By so doing all traces of chlorine will be removed and organic matters liable to affect the silver nitrate destroyed.

C. Procedure.

100 c. c. of redistilled chlorine-free water is measured out into two of the porcelain dishes and then 1 c. c. of the chromate solution added to each. The standard silver nitrate solution is run drop by drop into one of them until a distinct reddish tint or color is obtained which is permanent on standing five minutes. Using my own burette I have found that .1 c. c. of the silver solution where 1 c. c. = 0.001 Cl, is required to produce this decided color, and this .1 c. c. is the "error of observation" ordinarily employed. 100 c. c. of the water under examination is then measured into the third dish, 1 c. c. chromate added, and it is then titrated to the above tint of color *exactly*, which color must remain permanent after standing five minutes. This end reaction is slow in setting but is exact; the difference in the readings of the burette less the error of observation is the true amount of chlorine in the water.

Example:

Second reading of the burette	2.8 c. c.
First reading of the burette	1.3 c. c.
	1.5 c. c.
Less error	.1
No. c. c. silver solution required	1.4 c. c.
Equivalent to chlorine	1.4 m. g.

The whole can then be readily calculated to parts per million of water. In good clear light where the conditions of the test are kept perfectly uniform both in the comparison dishes and the unknown solution the definiteness of the end-reaction is surprisingly clear. The accuracy of this method can be readily proved by comparing results from definite quantities of the above salt solution and chlorine-free water. Silver solutions of less strength can be used if desired where the amount of chlorine is very low; below one part per million, e. g., it may be desirable to use a solution one-half or one-tenth as strong, i. e., 1 c. c. = 0.0005 or 0.0001 Cl., but I have found that a solution of a strength of 1 c. c. = 0.001 m. g. chlorine is usually the best for all work. This method is to be recommended also because it does away with the concentration of the waters, involving, as that does, loss from spattering and direct volatilisation of the chlorides, and the necessary attendant loss of time. Where waters carry extractive matters as do many of the river and lake waters of this section of the country, receiving the lixiviations from the swamps, imparting to them a high color, the method can be applied satisfactorily if some finely powdered, absolutely chlorine-free alum, or better, a little precipitated aluminum hydrate, be first added to precipitate the dissolved organic matters; after standing over night the requisite amount can be removed with a pipette. The color will then be discharged, the water clear and bright with no masking of the sharp definite end-reaction.

When the chlorine is as high as twenty parts per million or thereabout, it is advisable to add to the dish used for matching the color enough standard sodium chloride solution to represent about the same amount of chlorine as a preliminary test shall

have shown to be present; this is done because the color is decidedly different when there is much precipitated silver chloride, thus masking the end-reaction, but if the chloride be added to the comparison dish and the first change therein noted it will materially assist in the final determination of the end-reaction of the unknown water.

There is little call for discussing the sanitary significance of chlorine for it is well understood already. But what I want to emphasize here is the fact that natural, perfectly wholesome waters always carry some small amounts of chlorine in some form, generally as the sodium chloride. It makes little difference whence these chlorides come in a true unpolluted natural water or whether they were at some period the product of the animal economy as the natural processes of purification have been at work and the accompanying undesirable matters have been removed. All of this is within the field of research of the sanitarian, and the healthfulness or the reverse of such waters becomes a study for the biologist fully as much as for the chemist. The character of such waters is all the more difficult to pass upon because the chlorine is in such very small amounts and the analytical difficulties increase with the diminution of the amounts of dissolved matters. The exactness, therefore, of the method becomes of great importance. It makes little difference with the interpretation of results from the sanitarian standpoint whether a water carries 99 or 100 parts of chlorine per million; but the difference between 1 and 1.1 parts may be the difference between normal and polluted waters.

Further, the exactness of the method also may well be scrutinized carefully in waters carrying so little chlorine where the results of different analysts are to be compared. Does not the personal equation in the observations of different analysts play an important role here? In what other way can we reconcile results we sometimes read given out by those in whom we have the greatest confidence?

Before closing this brief paper I would like to call attention to one of the needs of the state, viz.: the accurate determination of the normals in chlorine for Wisconsin waters, as has been done in some of the other states. The need for such normals is apparent to those having to do with this kind of investigation.

Some work has been done along this line at this laboratory already and items are added as opportunity presents itself; it is no easy matter, however, to secure samples above suspicion and therefore the work is slow, as the expense of securing these samples is quite an item. In the determination of these normals we have encountered the very difficulties alluded to above, and the low chlorine content of most of our Wisconsin true inland waters requires the selection of the method promising the greatest exactness in results. So far as our experience goes the method given is the most satisfactory yet proved and is presented here for your consideration. The writer has drawn freely on all available data, written or unwritten, and gives this as a method, modified and developed, which he has found invaluable in his own laboratory experiences.

Beloit, Wisconsin.

HOUSEHOLD WORDS: THEIR ETYMOLOGY.

JAMES DAVIE BUTLER, LL. D.

All men are born etymologists. One of the Mammoth Cave traditions points this way. When the guide exhibits stalactites and visitors ask why he calls those stone icicles by that name he is said to answer, "Because they stay there tight," and regarding the counter concretions built up from drops which have fallen on the floor he will say, "These we call stalagmites because they might stay but did not." This tradition has some grain of truth. I was telling it long ago to the negro who led me through the wondrous cavern just where a stalactite from above and a stalagmite from below had blended in a sturdy pillar. Pointing to this curious creation my mentor said, "Here is something which I shall call a stay-mighty-tight." I could not enough admire this brand-new and new-born vocable which has no doubt done yeoman service ever since. It proves that wherever there is a folk there will be folk etymology.

The present paper will not try to set forth the varied phases of etymology whether popular or scientific. Nor will it deal with principles, rules, and classes of change as shown in Grimm's law, or in the treatises of Max Müller, Skeat, and divers American philologists. My purpose is merely to present specimens of every-day words concerning the origin of which there is now a general agreement. Brevity also obliges me to be content with a fraction of that limited vocabulary. Hence my range extends no further than what I term *household words* and to a small section of these, mainly those whose etymological meaning was long hid from my own eyes.

The atoms which it is my task to combine are chaotic, and my fear is that in twisting this rope of sand I shall throw dust in the eyes of all around me.

Family may well come first among household words. The word originally meant a collection of servants or slaves. The man did not belong to his family, but his family belonged to him. The prehistoric wife like the Sabine women, was obtained like other slaves, by capture, and the children could have no higher standing than their mother. Such is the English of the Roman legal formula; *partus sequitur ventrem.* The word family is derived from famulus = servant, which in the adjective familiar stands in the English Bible without change of meaning. I Sam. xxviii. 3. The familiar spirit of the witch of Endor was a servant spirit who at her bidding brought up Samuel from the dead. Servants of the inquisition, especially constables, are now called familiars, and the root-word famulus is used by Carlyle more than once, and that in its radical sense. *Servant* is etymologically one "preserved," a prisoner, saved from the slaughter which in earlier times had been the doom of all the vanquished, but preserved no longer than suited the caprice of his master—or house-despot—as he was styled in Greek. *Slave,* a word of similar import to servant, originally denoted captives of the Slavic or Slavonic race from which the Teutons took most captives. By one of the ironies in linguistic history it happens that slave in its original tongue signifies glory. The primitive constitution of families early underwent some changes to the surprise of Solomon, who says, "I have seen servants on horses, and princes walking as servants upon the earth." More recent changes as to what the word family implies are known and read of all men.

House and *hut,* words radically the same with hide, mean a shelter or protection, often in secret. *Home,* at first associated with lair or place of lying down, also implied a hiding place. *Mansion* (mainsion) the house where a man remained after he had emerged from the roving, nomadic stage, naturally became superior to a transient pastoral hut. The permanent abiding-place of a dignitary is a *residence,* that is resit-ance, where he permanently sits, the syllable re being here intensive. *Loft,* a contraction from lifted, describes the highest room, called also *garret,* which means a look-out. *Thatch, tile,* and *roof* are all derivations from a classical root meaning to cover. *Shingle,* that is a *split,* alludes to the way in which that sort of covering

is made. *Door,* which is an another spelling of through, is that through which people enter and depart. The termination *-bule* in *vestibule,* meaning to throw, gives name to the room where we throw off something of our vestments. *Vestry* is a sacred clothes-room. *Threshold* is a modern form signifying tread-wood, *-old,* contracted from *wold,* meaning wood. Tread in 1611 still meant to thresh, for Paul speaks of the ox that treadeth the corn. I Cor. IX. 9.

The structure before the house-door bears several names, each suggestive regarding the thing it denotes. It was called *porch,* or *portico,* words derived from the portal which is near. It was called *stoop,* which in Dutch means steps, from the stairs which led up to it, and *piazza* which means *place* or square from the open space before its steps. The railing which shuts it in is indicated by the name *verandah* (Latin vara), stick, and other points in its make-up appear in the name *colonnade* and *arcade,* while *loggia* signifies a place for a lounge. *Awning* is supposed to be akin to haven and the name befits such a shelter from sun as havens afford from seas.

Stair, stirrup, and *stile* all come from one root, to climb, by one we climb to a chamber, by another upon a horse, and a fence by the third. In *stirrup* the ending *-rup* is contracted from rope and recalls the era when a climbing-rope was the horseman's only help in mounting. From the same root with climb is *climax* which is Greek for ladder and English for a means of mounting step by step to rhetorical heights.

A strip two feet wide round a house was called of old eaves-drip and then eaves-drop. It gave the name *eavesdroppers* to listeners who stood thereon for overhearing. *Squirrel* is a word so self-descriptive that whoever learns that it is Greek for *shadow tail* must be sorry that its significance has been Greek to him so long. *Arbor,* a bower or shady retreat, is in spelling identical with the Latin name of tree, but it is now held to come from *herb.* The *h* vanished as so often in English mouths, while the *e* was sounded like the letter *a,* as in hearth, heart, sergeant, clerk, etc. Its first sense was a grassy lawn, and its next a bed of herbs. So much for house preliminaries, which signify things outside the threshold.

Passing to apartments, the root of *hall* is cover; hall is cognate with hull and as the hull covers the grain of corn so the hall is covered by rooms around it. *Parlor* is a room for parleys, from the same source with palaver and parliament. It is the scene of domestic parliaments and was naturally borrowed by taciturn English from talkative French whom they also call parley-vous. *Drawing-room,* contracted from with or within drawing room, is the apartment within which ladies withdraw from the dining-table when their lords begin to "put an enemy into their mouths to steal away their brains." The phrase, *drawn-game* is plainer when we supply the obsolete *with.* It is one from which the parties withdraw. *Boudoir,* more private than drawing room, is the retreat to which wise women when tempted to scold betake themselves till their fit of sulks is over. Boudoir is literally poutoir, a place for pouting, and is radically the self-same word with pout.

The word *niche* originally meant shell, niches being hollow like shells, which, set up against a wall, may have led to making the first niches. Niches when heading in shell-shaped reliefs or formed out of real shells point to their own origin.

Cuspidor is from spue and was born into English in 1779. *Cigar,* which means locust or grasshopper, got its name as being shaped at the end like the belly of such insects. It came from Spanish so recently that its earliest American appearance in print thus far discovered was in 1785, and its earliest use was only thirty years before.

Wall-paper was till recently called paper-hangings and the word *hangings* carries us back to the tapestry which used to be hung round rooms for checking drafts of air, another name for the arras (so called from the French town where it was largely made) behind which both Polonius and Falstaff were ensconced. The first *carpets* were all of rags, for the Latin root of carpet, carpere, means to tear, a word used to describe pulling wool off the backs of sheep before shears were invented—a meaning still figuratively alive in our saying to carp at. This rag-cloth, meaning at first a monk's robe, next meant hangings of tapestry, and next a table-cloth. Hence arose the phrases *on the carpet* and *on the tapis* (Greek for carpet). Then it came to mean the rugs on which men kneeled to be dubbed knights and

so gained the name of *carpet-knights*. Last of all was the sense of covering a floor in full.

The word *lamp* is from a Greek root which means to shine. The text "Let your light so shine before men" is literally, Let it so lamp before them. The same element forms the middle syllable in *Olympus*, which is thus the shiner, or lamp of mountains. The mirror with wings like a butterfly gets its name of *Psyche-glass* because a butterfly was called Psyche by the Greeks. The table before such a glass being covered with cloth was called *toilet* from a word meaning to weave. The origin of *bureau* is derived from a name of the baize that covers it.

Dressing is more than putting on clothes. It implies that it is hard to know how to put one's things on, going through that process *comme il faut*, that is rightly; yes, those laborsome and dainty trims wherein, as Shakespeare tells us, daughters of earth make great Juno jealous. Its Latin root means to make straight and is illustrated by the military orders: "Right dress" and "Left dress," and our vernacular "put to rights" which is to re-dress. Spelling prevents some persons from noticing that *raiment* is an abbreviated form of arrayment and so means something more than clothing.

The vocabulary of our vesture is often no less obscure than that of architecture or furniture. *Cloak* and *clock* are doublets, coming from the German word for bell, the latter so called as sounding the hours with a bell, and the former as giving its wearer the shape of a bell. *Mantle* comes from the Latin word for hand. In Virgil it means a table-napkin for wiping the hands. Its sense was extended to a table-cloth, and in dress to mantle as covering everything like such a cloth, and then the meaning narrows in the diminutive mantilla. The noun *stocking* comes from the verb stick as it denotes that into which a foot is stuck, as a malefactor's feet were stuck through holes in a plank,—the village stocks still to be seen in England. *Sock*, a doublet of stocking, is a variant of the socket into which a foot is set. The form stock for stocking occurs in The Taming of the Shrew where Petruchio's lackey comes in "with a linen stock on one leg" (iii. 2, 67). *Nether-stocks* is a Shakespearian name for stocking. Falstaff says, "I will sew nether-stocks and mend them and foot them too." 1 H. IV. ii. 4, 130. The word

nether-stocks implies upper-stocks and over-stocks which meant trousers,—called knee-breeches because cut off at the knee, and trunk-hose because covering the trunk of the body. Hose had once a wider meaning including upper and nether stocks joined in one single garment. St. Pantaleon was one of the patron saints of the Venetians and so often gave them baptismal names —all the more as his name means All-lion. Venetians were hence nicknamed pantalooners as naturally an an Irishman is styled Patrick. A variety of indispensables borrowed from those pantalooners may at first have been known as pantaloon-trousers, but could not fail to be shortened into pantaloon pure and simple, in accordance with a law which, reducing every word to its lowest terms, has now left us only pants. But I must pass by dress thus briefly for it lies mostly beyond my research or power to explain.

The members who make up the personnel of a household bear names of more significance than is at once apparent.

The name *man* meaning thinker shows him to have been from the start egotistical, or he would not have arrogated such a name. *Woman*, which is wife-man, proclaims her if not a rib, an adjunct or variation of the genus man. *Wife* which has been interpreted to mean timid as brides are, or inspired as the wives of ancient Teutons were esteemed, or weaver as few wives now are, more probably means merely woman, that is, *the* woman of some particular man. A meaning dead in a simple word often survives in a compound. *Husband* is a house-dweller—not a wanderer abroad. The termination *band* instead of its obvious sense is equivalent to *bor* or *bour* in *neighbor* and the Africander *Boer,* which means settler, one who is not a nomad. So Othello says in reference to his marriage,

> "But that I love the gentle Desdemona
> I would not my *unhoused* free condition
> Put into circumscription and confine."[1]

Mother, signifying the measurer, defines her as the domestic manager setting bounds to the household as she always must, moulding it when most plastic, and creator of the mother-tongue

[1] "Unhoused" is an Italian idiom equivalent to un-husbanded, and is held by commentators as one of the best proofs of Shakespeare's acquaintance with the Italian language. Othello, I. 2, 29.

and mother-wit. *Lord* and *lady* both owe their names to the loaf of bread. His name is contracted from loaf-ward, loaf-keeper, and hence defender and dispenser; lady is contracted from hlaf-doegan which is loaf-kneader, she who kneads the dough. The root of *father* is traceable in the compound foster-father. Foster is a contraction of foodster, so that father means a feeder.

The dropping of d in foodster illustrates a linguistic law which explains many obscurities, namely that a lingual or liquid can not stand before the letter s. In accordance with this law the word gospel is formed from good spell by dropping d. In like manner worship comes from worthship—to treat as worth or worthy. So we get response from responds, suspense from suspends, etc. In fleur-de-lis an l is dropped before s, and so hides the derivation of lils from lilium. So the loss of d in necessity hides its origin in ne and cedo, and its self-descriptiveness as the unyielding.

A descriptive feature of many words comes out in their etymology. *Son* is one sown, as the seed of Abraham; *daughter* brings back to us the pastoral era, meaning milker, *sister* is said to be of the same stock as sweet, *cousin* is shortened from consanguineous, that is, co-partner in blood, and *cousins german* are those sprung from the same germ, that is, from one grandfather or grandmother.

A *menial* deriving his name from mansion was inferior in name to no other domestic till that name was demeaned by association with the adjective mean. On the other hand *sergeant, deacon,* and *minister,* which all mean servant, have been dignified through association with higher things. The word *servant* itself has a curious history. When prisoners of war who had usually been slaughtered began to find quarter they were said to be saved, as already stated, and they served. Thus the name servant keeps in mind both their service and their preservation. Reserved power is power re-saved. If preserves were not saved beforehand, they could never be served up.

Marriage names are expressive of things. Its name, ***handfast,*** described the joining of hands; *nuptials*—that is, veiling—brings to view the bride's costume, Milton's "saintly veil of maiden white;" *bridal*—shortened from bride-ale—emphasizes

the attendant banquet of good cheer, which of old consisted in drinks more than in meats. *Wedlock* shows the pair interlocked by a wed which may mean a ring or any pledge or visible sign of mutual vows. *Espousals* signify solemnizing the conjugal union (which is literally a yoking together) by joining in pouring out a libation, or drink offering. Matrimonial terms may lose something of glamour in the light of etymology. *Trousseau* becomes nothing but a bundle or budget, and *bride* is a breweress or broth-maker. *Lady* as we have seen is a kneader of bread, but *consort* is a sharer altogether in another's lot, a partnership which knows no limitations. *Mate* and *match* were of one origin, a word meaning fit for something else so as to complete it, but were afterwards differentiated so that we hear of those who are mated but not matched, and matched but not mated.

Know thyself is a short maxim yet has proved too long for man to learn. Names for some of the members of our bodies we are slow to analyze. Many elbow their way through the world yet cannot tell why their own elbows are so named. They forget that the syllable el- (or ell-) was once our name for arm, and then for a measure of an arm's length, a sense that is plain still in the proverb, Give an inch and he will take an ell. In the light of this obsolete meaning *elbow* is clearly arm-bow, the bend of the arm. *Finger* is allied to fang and so means a grasper, and *hand* has a similar sense because from the same root as hound, the game-grasper, and with apprehend. *Nail* being from the same root with nag teaches that nagging is a figurative scratching with the ends of the fingers. *Wrist* is what wrests or turns the hand, and is plainer when we find that foot-wrist was an old name for ankle. *Vertebrae* are also turners, the bones on which the body turns round horizontally, while *haunches*—literally bends, analogous to hinges—are what it turns upon up and down. *Instep,* if still spelled as once it was, instoop, would describe itself as the foot's stoop or bend inward to the ankle. *Muscle,* which means mouse, takes its name from its shape, and the ends which stretch it are *tendons* which is Latin for stretchers. Beginners in Latin are pleased to learn that the *uvula* at the root of the tongue means a grape-cluster, that the *clavicle* which locks up the chest means key, that a

certain vein is called *jugular*—meaning pertaining to a yoke—because near the yoke of the right and left ribs. *Nostril* is nose-drill, for it pierces the nose as drills do rocks. Some of us call a man *supercilious* and still have yet to learn the sense-meaning of the word we use. It is brow-beating, or an action above the eye-lids. The word was unknown to both Shakespeare and Solomon, yet both of them had the idea. "There is a generation," says one, "O how lofty are their eyes and their eye-lids are lifted up;" and the other's words are: "Unknit that threatening, unkind brow." *Artery* etymologically is an air-tube, and so perhaps was once pronounced airtery. No blood being found in arteries after death it was natural, since nature abhors a vacuum, to think those empty vessels to be air-pipes or ducts for vital spirits which were an ethereal fluid quite distinct from that in the veins. Shakespeare shared this error. "Plodding poisons," he says, or according to some editions, "prisons up the nimble spirits in the arteries." *Muzzle* is not a dignified word for mouth but it has an origin and relations worth knowing. It means a biter and is cognate with morsel and remorse. The letter d has dropped out of the middle of each (it being hard to utter before s, as has been already stated), but it remains in mordant. The *mordant* aids the biting of colors in dyeing. *Muzzle* is a biter, *morsel* is what is bitten, and *remorse* is an after-bite,—the worst of all. Instead of transferring from Latin the phrase "remorse of conscience" Anglo-Saxons translated it as the "Againbite of inwit," the title of an ancient poem dating from the year 1340. *Jaws* would be a plainer word if spelled now as it was in our Bible of 1611, that is chawes: "I will put hooks in thy chawes." A doublet of jaws is *chops* which is shortened from choppers.

Eating tools lead us on to the scene of eating. The names of things which meet our eyes at every meal-time often need elucidation. *Table,* like *cupboard* meaning a mere board, carries us back to prehistoric simplicity. *Trencher* used to mean a square board, a shape still surviving in the compound trencher-cap, which is equivalent to the shape of a plasterer's mortar-board. *Dish*, traceable to the classical discus or quoit, which means something thrown, thanks to its circular shape, gave name to German tables and to English plates, at first to

such as were round, and then to all of the class *Tumbler*, in the light of etymology, becomes historic. It was at first shaped like the horn cups of the pastoral era. It was called tumbler because, being pointed, it must tumble if set down unsupported, and so it stood in a socket. Tucking in the point which enabled a cup to stand alone, marked an advance in glass making. Older than that improvement is the Gothic word for cup, namely point, because made of a pointed horn, and in the Gothic Bible we find the text: "The point my father hath given me shall I not drink it?" John xviii. 11.

Many original meanings are quite unexpected. Thus *porcelain* means pig, or porklet. The name porcella, Portuguese for pig, was given to a shell because it was shaped like that animal's back, and then transferred to china which was enameled like that shell. Shape gave rise to one word and color to the other. *Salver,* the tray or waiter used at table for serving up or serving off, means a saver, not however of eatables but of eaters. The word is an heir-loom from times when poison was often secreted in meats and drinks and was much oftener feared, so that a pregustator, or fore-taster, was the most important servant in all great households. After the plates of guests had been filled, each of them put a morsel of every dainty upon the salver which was passed around by the pregustator. Not till the salver-bearer had eaten these contributions did the feast of his betters begin. According to Shakespeare when King John had been poisoned and a messenger told the news, saying: "The King I fear is poisoned by a monk, I left him speechless," the hearers asked, "How did he take the poison? who did taste for him?" His answer was, "A monk, I tell you, a resolved (resolute) villain whose bowels suddenly burst out." King John, v. 6. 23.

Dessert, which means served off, fitly describes the final course of a dinner. *Serviette,* derived by some from the same root as salver since it saves our clothes, is traced by others to serve as being serviceable. The root of *napkin* means cloth and has seen strange mutations, coming to signify cloth on a table, in the pocket, in the hand, and tied about the body. Napery, a table-cloth, in the diminutive napkin, aside from its current use gave its name to handkerchief, to map, forming its material before paper was known, and to apron for the same reason. *Apron*

was spelled napron till its initial was stolen by the article before it. So auger was once spelled nauger, adder nadder, umpire numpire, orange norange; nick-name and nonce still retain the initial n, nick being formed from an eke, that is an added name. *Saucer,* before tea was known, had a wider meaning than now. It is derived from salt which gave name to every variety of seasoned thing as well as condiment, which word means what is given with another thing to savor it. Hence the words salad, sausage, sauce and so on, all indicating something salted, and saucer, the dish which contained them.

Many foodstuffs are better known to us than are their names. *Corned beef,* a term obscure to most who eat it, is contracted from salt-corned, and corned means with kernels of salt as large as corn, what we now call coarse salt. *Buckwheat* became a more significant word when I ascertained that wheat is another spelling of white, and that buck is an obsolete form of beech. Buckwheat being three-cornered like a beechnut, is beechnut wheat.

Poach being a word kindred to pouch shows that eggs are said to be *poached* because they seem to be each in a pouch. *Toast* becomes self-explaining when we see it to be allied to torrid, and so is bread torrified. Drinking a toast finds explanation in the custom of putting toast in cups of wine. Something of it would sink to the bottom of the cup so that he who drank a toast must drink deep and drain his cup. Analogous is the word *carouse* which is made up of two German syllables that signify all out.

But nothing on our tables is such an etymological surprise as *cream.* This article, known in Italian as the flower of milk, in French as well as English is cognate in origin with Christ. Both come from a word meaning to anoint with oil. Cream is the oil of milk. Christen comes from chrism, the anointing oil used at baptisms, and Christ is the one anointed prophet, priest, and king. Few food names are less understood than cream. None is more misunderstood than *turkey.* Soon after the death of Columbus the turkey was discovered in Mexico by Cortez and through him was introduced into the old world. But how could an American product have gotten a name from an Asiatic empire? The misnomer resulted from geographical misconcep-

tions. America was reckoned a part of India till after the birth of Shakespeare by geographers, and long after in popular usage. The word America is found in Shakespeare only once, and then is followed by "the Indies" as if it needed explanation by an alternate name, just as in the same connection the word Belgia is followed by Netherlands. Both phrases illustrate Shakespeare's habit of bringing in an easier word directly after a hard one to clear up its meaning. The Indies here, according to the context, mean West Indies, a name under which a thousand American islands to this day are classed. But Turkey in English eyes was the dominant power in Asia and not least over India, and so all things from India might be deemed Turkish, as all things American have now become Yankee. Thus a fowl which came from any corner of India, a Turkish conquest, might naturally be called turkey, all the more inasmuch as a gobbler, or gobble-cock, when spreading himself at sight of a red rag rivals the traditional fierceness of a Turk. In buying turkey, and on countless other occasions, we need scales. The modern patent platforms scarcely deserve the name of *balance* which is etymologically two dishes. The old pair of balances hung in even scale and gave a demonstration of accuracy which no eye could fail to see. What artist will ever dare pluck the balance from his painting of the goddess of justice? Returning to food-names we note strange vicissitudes in import of the self-same vocable. Thus *oil* took its name from the olive which yielded it, but now gives name to products more or less similar, but which are obtained from manifold sources which seem totally dissimilar, as cotton-seed, East Indian ground nuts, fish, fowls, beasts, and the bowels of the earth.

The first syllable in *butter* is allied to bossy, our colloquial name for cow, and according to Curtius (Sec. 227) its second syllable is thought to be the same with tur in the word disturbed, so that the word butter means cow's milk shaken. *Cheese* appears to be cognate with case. If so, it is milk pressed in a case. *Buttery* would seem to get its name from butter, but linguists derive it from the vessels or butts of liquor which were there stored. Food and drink, however, being laid up in the same room led to confusing the name with pantry which is bread-room. *Pantry* is related to pan in *companion*—one with whom

we share bread—as *comrade* is one with whom we share a chamber or camera. Pantler is the name in Cymbeline (ii. 3, 129) for one who has charge of a pantry. In regard to entertainment and rooms for it, the Latin for stranger, hospes, is mother of *host*, entertainer of strangers, *hostel* or *hotel*, the house where they are entertained, *hospital* for sick strangers, *hospice* for pilgrim strangers, *ostler* one who cares for horses of strangers, and so on.

But we have perhaps kept within doors too long. In walking abroad from a house points of compass arrest our attention. They all owe their names to positions of the sun *East* is his position at rising, a word related to yeast, hoist and oust, and giving a name to Easter—the rising again of the Crucified Christ. Just the same is the meaning of the word orient and Levant in Latin. *West* is where the sun wasteth, analogous to occident which is Latin for falling off. *South*—midway between east and west,—comes either from seethe where he is boiling hot, or from sunth where the sun is most himself and sunneth. Meridian, meaning mid-day, defines his position then: "sitting in his meridian tower." *Noon* means ninth, and originally signified the ninth hour from six in the morning when day began. In those days anything eaten before three in the afternoon broke a fast day. But the food of hungry fasters was served up very promptly and more and more so, till minute by minute three hours were subtracted from fasts and noon became synonymous with mid-day. A noon-nap is called *siesta* = sixth, because taken at that hour. *Dawn* comes from day, and is a contract of dayening. *North* is a word of disputed origin. Some hold it to be he narroweth, because the sun at his northing has a shorter course than elsewhere. Another meaning assigned to north is left-hand because we see the sun on that hand whenever in orienteering we face the east, as was anciently the universal custom. A survival from this primeval usage is the word *orienteer* which is to find which way east lies—or our easting. *Orisons* are morning prayers, when the sun is in the orient.

Churches have usually been so orienteered that in entering them we face the east, that is, the rising sun of righteousness, and many words descriptive of churches must be misunderstood

by all who fail to keep this fact in mind. The word *church*, an adjective coming from Greek, means "The Lord's, belonging to the Lord." *Nave*, Latin for ship, took its religious sense from viewing the church as the ship of souls, and with allusion to the ark of Noah. *Altar* has the same root with exalted, that is, something raised up, a high-place for sacrifices to be offered on. Singers standing behind this church-center gave the name *choir* to the place where they quired, that is, performed their function. *Chancel* now used as identical with choir means lattice-work, and at first was applied to the screen between choir and transept. *Transept*, literally a hedge across, was so named because, lying at right angles to nave and choir, it is a hedge between them. *Aisles* mean wings, pinions each side of the nave and combining with it to form a winged ship, as if it would soar to heaven. In the verses of Moore:

". . . . a bark of light,
Sailing through heaven as if it bore
Spirits of earth, the good, the bright,
To some remote celestial shore."

Organ is a tool for work of any sort, and specifically the grandest of tools for musical work. *Rosary* is a bed or bouquet of roses, but if we believe the legend, when a virgin burning at the stake prayed for her murderers, the brands were transformed into roses which, created by prayer, became emblems of prayer, and a string of them formed a rosary, a series of prayers. *Sacrament* was a Roman soldier's oath, hence it designates whatever is supreme in sacredness. *Image* is a word which could need no definition did not contraction hinder us from seeing its connection with imitate. But for this it would appear as imitage, an imitation. The original of *chapel* is cape, which word was used to designate the shelter or shrine for that particular cape, half of which St. Martin had given to Christ whom he had met as a naked beggar. The name was first used in France where St. Martin was one of the chief saints, and naturally spread to sacred shelters elsewhere. *Cathedral* means seat—a church with a seat for a bishop. Of old all other persons stood or kneeled as they do still in the Greek church. Seat is shortened into *see*. *Minster* is the church of a monastery, which is an abode of monks, men who dwell alone, namely, separate from

secular society; while the name *convent,* that is coming together, bespeaks their union in sacred services. Those who live separate from each other are *hermits,* literally dwellers in a desert. *Priest,* an abridgment of presbyter, is Greek for elder. *Clergy* signifies *lot,* or portion, they being viewed as the Lord's own, his portion or lot. *Bishop* is overseer, a name whose connection with its adjective is obscured by changes in spelling. To make this connection clear we must spell one word e-bishop-al, or the other word—piscop. The word *episcopate* must owe its origin to this feeling of ambiguity or doubt as to the connection of noun and adjective. In *parochial* the elements are almost the same as in *neighbor,* which is nigh-dweller. Its noun is *parish,* which is Greek for near one's house. *Crucial* is a third specimen of words like parochial and episcopal where the adjective's connection with its noun is not obvious. It comes from cross which was the shape of ancient guide-posts at the parting of ways, and so gives name to *crucial* tests. They show us the way to go at points of divergence.

It is as true now as in David's days that "there is but a step between us and death," but no age has been so careful as ours to put out of sight the grand *memento mori.* We ape the bird who dodges hunters by hiding her head under her wing. Intramural interments have become criminal. But in early ages interments were made, if not in churches, as near them as possible, so that every church-yard became a burial-ground. *Cemetery* is etymologically a sleeping-place, and by Greek usage came to mean a bed room for transient guests. It acquired the meaning of burial-ground only after the advent of Christianity and thanks to the New Testament view of death as a sleep. The radical sense of *coffin* is a basket (as is clear from Wyclif), Matt. xix. 20. *Funeral* is what is done to a corpse; *obsequies* means following it to the grave. *Dirge* is the first word in an antiphon in the office of the dead which begins "Dirige (from which dirge is contracted), Dirige, Domine," "Direct, O Lord!" Ps. v. 8. *Requiem* is Latin for rest, the first word in a burial ritual which begins "Requiem eternam dona eis!" "Rest eternal grant them!" So it is said in Hamlet concerning Ophelia,

"We should profane the service of the dead
To sing a requiem and such rest to her
As to peace-parted souls." v. 1, 260.

Here, as oftentimes, Shakespeare is his own best interpreter, following a hard word with an easy one which illuminates it, as rest here after requiem is an excellent epexegesis.

Tomb, cognate with tumulus, is a burial-mound, though it is held by some scholars to mean cremation. At all events, the termination taph comes from the same source with typhus and typhoid which define burning fevers. Taph in a secondary sense means tomb or place of burial as we see in epitaph, the writing at a tomb, and cenotaph, an empty tomb. *Sepulcher*, derived from a root meaning to honor, shows not merely memory but respect,—a feeling to which the history of *mausoleum* gives the most intense expression. The widow of Mausolus built his tomb so well that she made his name immortal, while the Mausoleum, classed among the seven wonders of the ancient world, now gives name to every modern tomb which can boast any resemblance to its nature.

Scripture, a Latin word for writing, we limit by way of eminence to sacred writing, as in the phrase sacred scripture, for Holy Writ. *Chart, charta* (in Magna Charta), *card*, all essentially one, have been traced by some to an Egyptian source. It is more probable that we owe them to a Greek word which means to scratch. They all form a basis on which we scratch or write. The same root branches out in the word character which is made up of the scratches which life leaves on our natures—the tabula rasa or blank tablet with which each of us was born. *Bible* and *paper* are words of supreme interest. Etymologically they are two Egyptian names of the plant out of which the first writing material was manufactured; adopted by Greeks when they imported the material, they have spread over the whole earth, paper in a secular and Bible in a religious sense. They show that words called by Homer winged as if fugitive and dying as soon as born, in truth are supreme monuments. Older than the pyramids they shall outlive them, and fly through all space no less than through all time. They are of the grand humanities,

touches of nature which make the whole world and all ages kin, wherever there is knowledge or faith, or hope. What thing is so lasting as words?

Within my remembrance the teachers of language in many colleges were called Professors of Humanity or of the Humanities. They are still in Scotland. Nor is anything in the term there thought to be antiquated or peculiar. The idea in this entitling was that speech is by way of eminence the human characteristic, one denied to all the lower world. The worm can weave, the bee can build, but neither can talk. Similar seems to have been the feeling of Homer when, differentiating man from the animals, he styles him μέροψ (merops), the articulator, divider of the voice. The word μέροψ is highly exalted in the Homeric vocabulary, being used by the goddess of wisdom to describe the most sagacious class of men. The more I have studied words, their bearings and ties, strong connections, nice dependencies, the more my conviction has deepened that every language is itself a greater miracle than any work of the greatest genius who has ever written in its vocables.

TWO HUNDRED WORDS WHOSE ETYMOLOGY IS INDICATED.

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Madison, Wis.

A PROBLEM OF LONGEVITY.

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The question to which I invite attention was suggested to me during my work upon the determination of the inter-generation period, which I presented to the Academy last year. The somewhat unexpected results which I then obtained, pointing to a probability that that period has not appreciably changed from generation to generation, despite the markedly increasing size of families, suggested an inquiry what other constant periods might be found in studies of human life, a question emphasized at the Columbus meeting of the American Association for the Advancement of Science by the discussion of a paper presenting very careful and quite extensive investigations in relation to changes in the median age.

I am confident that few who have not given careful attention to that class of problems recognize the number of different questions presented for solution which are closely related and capable of being so confused as to present most erroneous results. I may mention the mean age of death in a community, the median age of its members, and their mean age, as elements in such investigations, the changes in which from generation to generation are often confounded.

It is, I assume, a generally recognized fact that human life has become longer in civilized communities, as the generations have passed, but the method of this change is not entirely recognized. The increase is often largely ascribed to a marked decrease in the death rate among infants. But the last report of the State Board of Health of Massachusetts, while indicating a marked advance in the median age of the inhabitants of that

state, yet shows no lessening of deaths among children below the age of five during the last fifty years. That is, perhaps, the gain in this respect due to an advance in pathology has been balanced by the increase in the number of children subject to the dangers of residence in cities. But the advance of the median age seems to be undoubted; from which we certainly infer a diminution of deaths in youth and early manhood, a fact which has brought into evidence certain philosophers of the class characterized by the couplet,

"And this the constant burden of their song,
One truth is plain, whatever is is wrong,"

who deprecate this preservation of individuals of feeble physique to become parents, and declare that a serious loss of average robustness and health has resulted, and that it is shown by a diminution in the number of people attaining old age, in spite of the increased mean age at death. Around the question of the truth of this assertion statistics have been marshalled with resulting conclusions by no means entirely harmonious, but apparently tending, I believe, to indicate the truth of the charge that the interference with the working of the law of the survival of the physically fittest is bringing in a race of weaklings. It is to one aspect of this question, which as far as I know has heretofore escaped notice, that I have given some attention.

In the search for evidence in relation to such a question, evidently the records of former generations are to be compared with those of our own time, and naturally the comparisons usually have been made between recent and remote records of the same region. Moreover the records of recently organized communities are not available for such comparisons, since they contain so few terms of the series; and hence investigations have been very largely confined to older regions, whence from generation to generation there has been an exodus of those who became pioneers in the formation of new communities. It is true that during the past few years many persons of feeble physique have emigrated to new settlements in quest of improved health; but that condition is quite recent. Generally it has been the strongest members of a community, those seeming most likely to endure, who have sought new homes and whose lines have passed out of the record of succeeding generations of their native region. The

resulting error in a conclusion based upon a comparison of records is evident, and I have tried to avoid it by substituting for a comparison between the records of successive periods in the same community that between successive generations of the same family or families; but I have not as yet been able to make my investigations sufficiently extensive to give a basis for anything more than a mere suggestion. My work has covered seven generations of three distinct families extending back to the middle of the seventeenth century in New England, and now widely scattered from their early home. The records of the two earliest generations, however, were obviously so deficient in the dates of death of children dying young that it seemed useless to consider them, and so many of the seventh generation still survive that that too, was necessarily omitted. I have tabulated below the statistics of the ages at death of the members of four generations, divided into five classes with respect to age at death, giving the per cent. of the whole dying within the limits of age of each class and their mean age at death.

Gen.	Below 5.		5 to 25.		25 to 50.		50 to 75.		Above 75.		Total mean.
	Per cent.	Mean	Per cent.	Mean	Per cent.	Mean	Per cent.	Mean	Per cent.	Mean	
1st.....	09.8	1.3	13.1	13	11.5	37	39.4	65	26.2	84	53.7
2d.....	16.1	1.2	14.2	19.5	19.4	38	30.3	62	20	84	46
3d.....	16.3	1.15	11.7	15.5	16.3	40	31.2	64	24.5	82	48.7
4th.....	12.9	1.4	11.7	16.5	20 6	37	31 8	62	23	81	48.1
All.....	13.9	1.3	12	16.5	19	38	31.9	63	23.2	82	48.5

The near approach to uniformity in the later columns of this table evidently suggests a serious doubt of the correctness of the theory of decreasing vigor as the generations pass, as far as so limited an investigation can have any weight in dealing with the question.

THE GOTHENBURG METHOD OF REGULATING THE LIQUOR TRAFFIC, 1892-1898.[1]

GEORGE THOMPSON, B. L.

A discussion of the establishment of the Gothenburg liquor system, of the principles upon which it is based, and of its operation through earlier years may be found in the Fifth Special Report of the U. S. Commissioner of Labor published in 1893. This report, which consists of two hundred and fifty-three pages, was prepared by Dr. E. R. L. Gould and is both authoritative and elaborate. It needs no duplicate. My aim therefore shall be rather to supplement it, to extend it up to the present time, to see whether or not the developments within the last six years correspond to the former developments which Dr. Gould has so clearly mirrored.

But it may not be amiss if by way of introduction we review in a cursory manner the results attained by Dr. Gould's investigations. In the concluding paragraph of his report, he says: "That the system is perfect no one will be sanguine enough to maintain; but that it represents the best means which have yet been devised for the control of the liquor traffic where licensing is permitted at all, few who understand its true character and have studied its operation will be bold enough to deny." In 1865 when the system was established in Gothenburg, the city from which it has derived its name, Sweden was a land of distilleries and dramshops. That nation was then known as a nation of drunkards. Of this curse of inebriety the new liquor system became a healer. As it began to operate drunkenness began to decrease enormously. For the country of Sweden, as a whole, the annual per capita consumption of spirituous liquors decreased from 10.6 litres in 1865 to 6.5 litres

[1] A dissertation submitted to the faculty of the University of Wisconsin for the degree of B. L., June, 1899.

in 1892. For many of Sweden's cities, which had shown for several decades an enormous amount of drunkenness, the decrease was still more marked. In Gothenburg the per capita consumption decreased from 24.81 litres in the year 1877–1878 to 13.55 litres in 1891–1892; in Stockholm the per capita consumption decreased from 26.56 litres in 1877–1878 to 13.63 litres in 1891–1892. In 1871 when the system was introduced into Norway the average inhabitant there consumed 5.3 litres of spirituous drinks a year; by 1892 the average inhabitant consumed only 3.2 litres, and Norway could claim, Italy excepted, that she had reached a degree of sobriety higher than any nation of the world.

Misery was greatly lessened. In 1865 there were in Gothenburg 2.36 cases of delirium tremens for every thousand inhabitants; in 1892 there were only 1.21 per thousand. In 1876 there were in Stockholm 5.27 cases of the same terrible disease for every thousand inhabitants, but in 1892 the number had decreased to 1.64 per thousand. For Norway the records of 1871 designate drunkenness as the direct cause of 2.9 deaths out of every thousand; in 1892 the number similarly designated was only .8 per thousand.

But the new liquor system came not only to curtail drunkenness and the miseries accompanying drunkenness but also, unlike all other liquor systems, to serve as a promoter of philanthropy. The profits accruing from the sales of liquor were no longer to fill the pockets of saloon keepers, but were to be used for ends furthering the general welfare. During the years 1877–1890 the company in Bergen alone contributed not less than $348,655.94 for such purposes. From 1886 to 1891 the company in Christiania contributed $312,006.24. Orphan asylums, schools, deaconess homes, reading rooms, temperance societies, and charitable institutions of various kinds were in this way materially assisted. The manner of the distribution has been more indirect in Sweden than in Norway (the former making larger amounts go directly into the public treasury), but the surplus has ultimately reached approximately the same destination in the two countries.

With this brief outline of the results attained prior to 1892, we pass to a consideration of the development of the system dur-

ing its operation in later years. In this study it will be best to treat of Sweden and Norway separately, for during recent years the developments have been so different in the two countries that what can be said regarding one can rarely be said of the other.

SWEDEN.

Sweden needs the less part of our attention, not because the Gothenburg system has worked less efficiently there, but because the recent developments of her liquor problem have not been much different from the developments of the years so elaborately discussed by Dr. Gould.

One surprise, however, meets us in the study of the operation of the Swedish Samlag system. Instead of finding a continued decrease of intemperance, we find a slight increase. From the Swedish official statistics I take the following table which shows the amount of spirituous liquors consumed for each of the later years:

Year.	Total consumption.	Per capita.
1891	31,018,505 litres	6.4 litres
1892	31,300,930 litres	6.5 litres
1893	32,150,388 litres	6.7 litres
1894	33,274,581 litres	6.9 litres
1895	33,458,068 litres	6.9 litres
1896	35,584,088 litres	7.2 litres
1897	37,059,454 litres	7.5 litres

In seeking causes for the increase of inebriety shown in this table let us first ask whether there have been in these years more saloons for the sale of spirituous liquors. The following table procured from the same Swedish Statistical Bureau will answer:

Number of places of sales.

(a) In the Cities.

Year.	Retail.	Bar.	Total.	No. of inhabitants per saloon.
1891–92	265	600	865	1,073
1892–93	268	576	844	1,111
1893–94	270	598	868	1,096
1894–95	269	605	874	1,115
1895–96	263	608	871	1,144
1896–97	264	613	877	1,164

(b) In the Country.

Year.	Retail.	Bar.	Total.	No. of inhabitants per saloon.
1891–92	35	137	172	22,536
1892–93	31	139	170	23,758
1893–94	27	131	158	24,666
1894–95	24	127	151	25,817
1895–96	27	128	155	25,307
1896–97	23	129	152	25,933

A glance at these figures, which show that in the cities as well as in the country there are more inhabitants now to every saloon than in 1892, proves conclusively that the increase in the per capita consumption, shown in the first table, cannot find an explanation here. The increase cannot be accounted for either by any lessening of prices, for during these years prices have rather been slightly raised; nor can it be accounted for by any increase in the use of spirits for scientific or industrial purposes for there is no evidence to support such an argument. We are therefore led to ask: Is there any positive evidence that drunkenness has increased with this increase in sales? Yes, there is such positive evidence. I find it in the statistics from both Gothenburg and Stockholm. In regard to Gothenburg the following table is the evidence which the liquor company itself gives in its report for the year 1898:

Year.	Amount of sales, litres.	Population.	No. of cases of drunkenness	No. per 1,000.
1892	1,441,517	106,356	4,563	43
1893	1,411,986	106,959	4,066	38
1894	1,414,222	108,528	3,665	34
1895	1,477,505	112,670	3,516	31
1896	1,531,499	115,521	4,040	35
1897	1,609,843	117,534	5,234	44
1898	1,753,485	120,151	6,546	54

Drunkenness has evidently increased considerably in Gothenburg. A still further substantiation of this fact is found in the following table which shows that the alcoholic diseases, the natural concomitants of drunkenness, have also increased:

Year.	Sales per capia, litres.	No. of alcoholic diseases.	No. of diseases per 1,000.
1892	13.2	129	1.21
1893	13.0	153	1.40
1894	13.1	163	1.50
1895	13.1	153	1.35
1896	13.2	205	1.77
1897	13.6	189	1.60
1898	14.6	235	1.90

These statistics are incontrovertible and are sufficient for Gothenburg. Turning to Stockholm, the capital city, we find a like tendency there. The sale of spirituous liquors in the last two years is the largest within the records of the company system of that city. From the annual reports of the Stockholm company I derive the following table:

Year.	Population of city.	Total no. of litres sold.	Litres per capita.
1891–92	248,051	3,381,766	13.63
1892–93	249,246	3,488,825	14.00
1893–94	252,936	3,429,468	13.56
1894–95	259,304	3,613,155	13.93
1895–96	267,100	3,812,715	14.27
1896–97	274,611	4,280,961	15.59
1897–98	283,550	4,288,062	15.12

In regard to drunkenness and alcoholic diseases the following table derived from similar reports tells the condition better than words:

Year.	No. of alcoholic diseases.	No. of cases of drunkenness.	No. of alcoholic diseases per 1,000.	Cases of drunkenness per 1,000.
1892	408	8,122	1.64	33
1893	420	7,863	1.66	31
1894	455	8,073	1.75	31
1895	504	8,828	1.89	33
1896	574	10,669	2.09	39
1897	688	11,592	2.43	41

Combining the four preceding tables, we find that Gothenburg presents an increase of 1.4 litres in the consumption of spirituous drinks per inhabitant, and an increase of twelve cases of drunkenness and of .75 cases of alcoholic diseases for every thousand inhabitants; while Stockholm shows an increase of 1.49 litres in the per capita consumption, and an increase of eight cases of drunkenness and of .79 cases of alcoholic diseases for every thousand inhabitants.

This increase in drunkenness and in alcoholic diseases is not due, however, to the larger consumption of spirituous liquors alone. There has been in the later years an increase in the consumption not only of spirituous liquors, but also of the milder beverages such as ale and wine. As the sale of these beverages, however, has not been under the absolute control of the company

system, but has been conducted for the most part by private individuals, no exact figures as to the total amount of sales are procurable. But, as a criterion by which to estimate the increasing consumption of ale and wine, I have here a table which has been procured from the Gothenburg police and which shows a record of the testimony given by the persons arrested for drunkenness when questioned as to what kind of liquor constituted their last drink:

Number answering:

Year.	Ale or wine.	Brandy.	Not accounted for.
1892	1,230	1,824	1,765
1893	1,044	1,640	1,566
1894	1,007	1,398	1,408
1895	995	1,331	1,352
1896	1,270	1,477	1,483
1897	1,670	1,759	2,138
1898	1,933	3,234	1,661

These figures, although an indirect basis for a comparison of the consumption of the milder with the stronger liquors, are cited here rather to substantiate the testimony of the Swedish press and of the prominent Swedish authority, Sigfried Wieselgren, in their affirmation that the sales of liquors of all kinds have been rapidly increasing during recent years.

In contrast then to the promising picture painted by Dr. Gould the present condition of the liquor movement in Sweden presents an apparently gloomy state of affairs. Inebriety with all its evils seems to be increasing in that country. Must we therefore say that for Sweden at least the Gothenburg system has outlived its usefulness? It would, of course, be rash to assume that the present tendency is simply a natural and temporary reaction from the many preceding years of increasing sobriety. But it must also be remembered that in seeking the causes which lie behind any amount of drunkenness, we are dealing with a subject so intimately interwoven with economic and ethical conditions, that it is folly to press too eagerly in one and only one direction.

A greater prosperity accompanied with higher wages always permits a more extensive satisfaction of the desire for intoxicating liquors, providing saloons are near enough to make that desire easily satisfied. A recent rise in the prosperity of Sweden must certainly be accounted one of the causes for the present increase in drunkenness in that nation. Ernst Hudrie, the present manager of the Gothenburg samlag, says: "With the recent rise in prosperity have come higher wages, and with higher wages a great increase in the consumption of liquor by the laboring classes." Another factor frequently referred to in various reports is the dispersion among the people of a vast amount of sensual literature. How far such literature may have any influence must be, however, entirely a matter of conjecture. But a third factor which has also been suggested,—and in my opinion this is of more weight than the second,—is the fact that Scandinavia is becoming more and more a center of attraction for tourists. Tourists in large numbers often make Gothenburg, Stockholm, Upsala and other cities their summer resorts. The liquor consumed by them, however, is, in the general statistical reports, counted as if it were consumed by the native inhabitants, thus making the per capita consumption somewhat greater than the amount really consumed by the average inhabitant of the land. But still after making reasonable allowances for these factors there evidently remains a large margin of the increase unaccounted for, an increase which speaks plainly of a greater inebriety on the part of the Swedish people. Whether, however, there is on this account any reason for condemning the Gothenburg system will, I trust, become more evident after we have considered Sweden's sister state, Norway.

NORWAY.

There are special reasons why Norway's liquor problem is at this time both more interesting and more significant than that of Sweden. It is right in Norway, and just in these years, that the Gothenburg system and the liquor problem of the North is really being tested. How and under what conditions,—that is the problem we must seek to investigate.

We shall first ask,—what has been the trend of the consumption of spirituous liquors for Norway at large during the recent period under our consideration? From a special report of the Statistical Central Bureau I derive the following table:

Year.	Total consumption.	Per capita.
1892	6,438,000 litres	3.2 litres
1893	7,142,000 litres	3.5 litres
1894	7,628,000 litres	3.8 litres
1895	7,111,000 litres	3.5 litres
1896	4,827,000 litres	2.3 litres
1897	4,637,000 litres	2.2 litres
1898	.....	2.3 litres

The definite amount of the consumption for 1898 has not yet been ascertained. The Central Bureau, however, estimates it at 2.3 litres per capita.

For Norway at large then we have in the preceding table a clear demonstration of a decrease of about .9 of a litre in the per capita consumption since 1892. The reasons for this condition will become apparent as we proceed. Here it may suffice to remark that the table refers only to spirituous liquors and that sobriety has not been increasing everywhere alike. In several of the larger cities we find a marked increase rather than a decrease of drunkenness.

Bergen is a prosperous city of sixty-five thousand inhabitants. It has so often been discussed by the various writers on the Gothenburg system that a knowledge of its recent conditions will be of especial importance. Ever since 1877 samlags have been in active operation among her people. As shown by Dr. Gould the sales of spirituous liquors decreased from 282,128 quarts in 1877 to 250,881 quarts in 1888, while it increased again from the latter number to 331,342 quarts in 1891. A general knowledge of the condition from 1891 to the present time may be obtained from the following table derived from the latest reports of the samlags in the city:

Year.	Total sales.	No. arrested for drunkenness.
1892	334,123 litres	690
1893	338,485 litres	815
1894	319,719 litres	943
1895	301,951 litres	1,381
1896	294,025 litres	1,866
1897	351,059 litres	1,789
1898		

Here, then, as in Stockholm and Gothenburg, we find not increasing sobriety but increasing inebriety, larger sales of spirituous liquors, and larger numbers of arrests for drunkenness.

As to whether the above number of litres is a correct criterion for the amount of spirituous liquors really consumed in Bergen, it should be noted that statistics for separate cities give us information regarding the sales by the samlags alone. While it is true that in Bergen and in most of the other cities samlags have had exclusive control over the retail and bar trade, wholesale merchants have, however, nearly everywhere sold more or less liquor directly to the consumers. This statement in regard to wholesale merchants must, however, be taken with some limitations. In the first place it is hardly true for Sweden at all, for in that country the wholesale merchants have been bound by law not to sell in quantities less than two hundred and forty litres, an amount generally too large for individual purchase. In the second place, the statement is true for Norway only up to the year 1896, when a new law went into force, which raised the allowable minimum purchase at wholesale from twenty litres to the amount legitimized by the laws of Sweden. The bearing of this change will be brought to our attention later.

Another city which deserves separate attention is Christiania, the capital of Norway. It has now a population of about two hundred and ten thousand. Samlags have operated there since 1885. In 1886 they sold 282,843 litres of spirituous liquors, in 1891 they sold 396,368 litres. A knowledge of the amount

of their sales during the later years and of the condition of drunkenness may be gained from the following table, derived directly from the annual reports of the samlags of the city:

Year.	Sales in krowns.	Sales in litres.	Arrests for drunkenness.
1892	1,326,139.13	422,664.6	11,496
1893	1,330,275.13	409,415.4	12,876
1894	1,331,426.78	387,091.3	12,611
1895	1,624,425.44	461,301.9	13,526
1896	1,431,219.06	363,653	19,249
1897	1,604,717.61	396,117	21,521
1898	1,963,261.13	483,465	19,582

It is to be noted, however, that this table does not show the entire amount of spirituous liquors consumed in Christiania even as well as the preceding table does for Bergen. In addition to the sales by samlags and the sale by wholesale merchants there has been in Christiania a considerable sale of spirituous liquor in bottles by, on the average, twenty-nine private liquor dealers. These private liquor dealers hold their right to the trade as a result of earlier liquor legislation and, unless expropriated, will in all probability continue to exercise their rights as long as they live.

To ascertain the exact amount of spirituous liquor consumed in Christiania, it is evident that it would be necessary to add to the sales by the samlags as given in the preceding table, not only that part of the wholesale trade which is direct to consumers, but also the sales of the retail liquor merchants of the city. The extent of these additions cannot, however, be exactly determined; in the first place, because wholesale dealers have not kept distinct records of those sales which before consumption did not go through the hands of the samlags or of the private liquor dealers; and, in the second place, because the private liquor dealers, like so many other private establishments, have kept no records of their sales at all, at least no attainable records. No one can, therefore, tell how much is consumed in Christiania. All we can attempt to do is to arrive at an ap-

proximate estimate. Such an estimate, based on the fact that, unlike the samlags, the private liquor dealers are pursuing a business strictly for private gain and on the further fact that the number of private retail saloons in the city is greater than that of the samlags by one, it seems—and this is the opinion held by Norwegian authorities such as Aarestad and Irgens, noted and keen observers of the conditions as they find them in Christiania—that there is no exaggeration in saying that the private dealers have for a considerable number of years supplied at least one-half of the spirituous liquors consumed in Christiania. For a somewhat reasonable estimate of the total consumption in the capital city, then, we may simply go back to the preceding table and multiply by two the figures found in the column under "number of litres sold." From these facts we may also draw the following inferences: first, that the samlags have not had a very firm grip on Christiania; and secondly, that it would be grossly erroneous to attribute the city's increase in drunkenness to them alone. We shall later see whether it is fair to attribute it to them at all.

It is evident, as before intimated, that in dealing with the consumption of liquors we should present an incomplete account were we not to consider the sales of ale and wine which during recent years have been increasing enormously. As in Sweden, the sale of these beverages has been conducted not so much by samlags as by private individuals. Ale and wine have not been considered as dangerous intoxicants by Scandinavia, and in no place, therefore, have they come under the absolute control of samlags. The license for selling these beverages, too, which at its highest cannot, according to law, exceed $107.20, is so small that the business of the ale and wine traders has become exceedingly lucrative. In Christiania we find not less than 282 of these traders and in nearly every city they are becoming more and more numerous. It is impossible for the samlags to compete with them for they, unlike the samlags, are not bound by strict rules and regulations. Out of this source arises a difficulty which we shall consider later on.

From the preceding data it should now be evident that the total amount of liquor consumed in Norway is made up of

various factors: (1) the sale of spirituous liquors by the samlags, (2) the sale of ale and wine by the samlags, (3) the sale of liquors in bottles as found in Christiania, (4) the sale of ale and wine by private merchants, (5) that portion of the wholesale trade which is direct to consumers. As there are no means by which to estimate definitely the exact force of the last three of these factors, the Central Statistical Bureau of the kingdom has based its estimate of the total amount of liquor consumed in the whole realm upon the total home production, minus the quantity exported, plus the quantity imported, minus the approximate amount used for industrial and scientific purposes. Thus it estimates that for 1897 the per capita consumption of liquors was as follows: spirituous liquors, 2.2 litres; ale, 17.8 litres; wine, 2.66 litres. For separate cities, however, such a basis of course could not be applied.

We have seen that Bergen and Christiania, the two leading cities of Norway, both show an increase in drunkenness. In thirteen other cities records show a similar sad condition. The most important of these are: Kristiansand, Trondhjem, Holmestrand, Mandal, Röros, Lillesand, Molde, and Tromsö. But the condition is for the better in many cities. Records tell us that in as large a number as thirty-six drunkenness is decreasing. Among these more happy places may be mentioned: Fredrikshald, Dröbak, Drammen, Brevik, Grimstad, Namsos, Hammerfest, Gjövik, and Florö.

There is thus a tendency towards sobriety in some cities while there is a tendency towards greater inebriety in others. That being the case among the cities we ask,—what is the condition in the country? Our answer is not difficult, for in the country districts of both Norway and Sweden prohibition has reigned nearly everywhere for a considerable length of time. In Norway there is in the country but one saloon for every 12,800 inhabitants; in Sweden there is only one to every 30,839 inhabitants. Such conditions are unparalleled the whole world over. It may be noted, too, that this happy state of affairs is not due to any special prohibitory law. The fact is that the country people of Scandinavia, taken as a whole, do not want saloons. Like the cities they could have samlags or they could

have licenses granted to private individuals, but, except in a few instances, they hold aloof from both. There are two hundred and eighty-one districts out of four hundred and seventy-eight in which there is no liquor traffic whatever. In four hundred and thirty-five out of four hundred and seventy-eight, drunkenness has been markedly decreasing within the last years; in thirty, observations seem to indicate no change; while drunkenness seems to be increasing in only ten.

Having now surveyed, in a general way, the liquor traffic both in the country and in the cities, necessarily in a cursory manner, however, we pass to a consideration of a few particular phases of the problem which are especially interesting and significant as being products of recent developments.

The first, though perhaps not the most interesting of these phases is the so-called "Ladde traffic." This has aroused considerable excitement and has been the source of much trouble. The "Ladde traffic" is the importation and sale of a cheap kind of wine. It has been largely imported from France and Germany. As to its nature I find among my various reports the following description: "It is sweet and delicious but made of poor material and has none of the genuine characteristics of good wine." The fact remains, however, that this wine has won much popularity with the Norwegian people, both on account of its cheapness and its taste. While a bottle of brandy containing thirty-six per cent. alcohol costs 1.20 kr., a bottle of the same size filled with "Ladde vin" that contains twenty-one per cent. alcohol costs only .40 to .50 kr. (40 to 50 öre). That it can be sold at so low a price is due to the fact that, being designated as wine, there is in the first place only a very small tariff on its importation, and in the second place, practically no license for its sale. It may be and is sold by nearly every local merchant—thus it is made easily accessible. That this is a detriment to a struggling movement towards sobriety is evident. Of what account is it to bind samlags or any other organizations by strict rules if private individuals are left free or are given extraordinary privileges for working towards results directly contrary to such rules? The importation and consumption of wine has greatly increased. To show the extent as well as the recency

of this "Ladde" development I have procured a table which goes a little farther back than the period covered by this paper:

Year.	Amount imported.
1881–85	1,672,500 litres.
1886–90	1,727,900 litres.
1891–94	2,320,300 litres.
1895	2,967,300 litres.
1896	4,943,500 litres.
1897	5,606,600 litres.
1898	About same as for 1897.

The "Ladde" problem is thus a problem which has come up within very recent times for "Ladde" is the sole cause of the enormous rise in the quantity of wine importation, a rise of two and one-half million litres since 1895, as shown by the above table. How to meet this traffic is a burning question in the liquor problem of Norway to-day. Neither it nor the ale traffic can continue in their present condition. More restrictive measures must be placed on both. Both, as we shall hope to show, should be placed under regulations similar to the regulations governing the traffic in brandy.

The second new phase which we must consider is the interesting movement arising from a new law drafted in 1894. An article of that law provides that, from that time on, a general ballot, to which all resident men and women over twenty-five years of age are alike eligible, shall determine whether or not samlags shall continue in the respective municipalities; the result of balloting, as determined by a majority of votes shall be binding for five years, when again a new ballot may be taken. This provision, touching as it did the very heart of the Gothenburg System, aroused interest and excitement everywhere. Shall the wise system survive? An abundance of advocates was found on both sides. The samlags tried every possible means to maintain public opinon in their favor. The teetotalers and the temperance societies generally were strongly aroused,—to them the coming election was to bring their desired victory for prohibition. The first election was held in 1895. It was marked by great excitement wherever it took place. In an interesting treatise I find quotations from various Norwegian

newspapers. Speaking of the commotion in Risör, one of the cities where samlags had operated for a long time, the well known Norwegian paper, "Fädrelandsvennen," says: "The week just passed has been an exciting one for Risör, a week of strife and battles. Agitation for and against the brandy samlags has been conducted with all possible vigor and vehemence; hardly any grown person has remained entirely unaffected by it." And here is another written shortly before election time. It is reported in the form of a telegram from the city of Tönsberg. "The samlag agitation is growing more and more intense as the time for balloting approaches. The papers are full of condemnations and exaltations of the present liquor system; fly-leaves by the thousands are being scattered daily by both parties. Never has there been a political campaign that has brought so much strife or so much excitement." Other quotations might be cited, but these will suffice to indicate the general heat of the contest.

Strange as it is the records of the ballots of 1895 show a majority not in favor of but against the samlags. There were thirteen cities in which balloting took place, and of these there were eleven in which the prohibition element won the day. As the record of the votes is very important in showing the trend of public opinion, I have procured tables from the Statistical Central Bureau which show the exact condition. These tables are made complete and absolutely correct.

Balloting of 1895.

Cities.	Result.	No. of voters.	No. for samlags.	No. against.
Gjövik.....	To discontinue from Jan. 1, 1896	800	328	472
Aasgardstrand....	To discontinue from Jan. 1, 1896	210	69	141
Tönsberg.....	To discontinue from Jan. 1, 1896	3,654	1,685	1,969
Brevik	To discontinue from Jan. 1, 1896	1,088	522	566
Skien.....	To discontinue from Jan. 1, 1896	4,249	1,696	2,553
Risör.....	To discontinue from Jan. 1, 1896	1,616	549	1,067
Arendal	To discontinue from Jan. 1, 1896	2,073	787	1,286
Grimstad	To discontinue from Jan. 1, 1896	1,476	602	874
Aalesund.....	To discontinue from Jan. 1, 1896	4,359	1,137	3,222
Molde	To discontinue from Jan. 1, 1896	838	322	516
Namsos	To discontinue from Jan. 1, 1896	965	234	731
Bodö	To continue.....	1,814	1,217	597
Vadsö	To continue.....	649	534	115
Tot., 13 samlags 11 to discontinue, 2 to continue.....		23,791	9,682	14,109

From this table we see that of the total number of votes cast 61.5 per cent. were against the samlags while only 38.5 per cent. were in their favor. This result may seem like a passionate reaction but it was not. It was the expression of a wholesome temperance spirit which had long been gaining strength in Norway and which was now given freedom of action.

Having voted down the samlags the problem interesting to all was: Will prohibition improve matters? Before considering this, however, and as preliminary to this consideration we shall do well to study the election records for the later years.

Balloting in 1896.

Cities.	Result.	No. of voters.	No. for samlags.	No. against.
Drōbak	To continue	1,091	757	337
Kongsvinger	To continue	606	539	67
Lillesand	To discontinue	720	250	470
Farsund	To discontinue	857	377	480
Sogndal	To discontinue	213	98	115
Stavanger	To discontinue	11,756	4,234	7,522
Bergen	To continue	28,762	14,590	14,172
Levanger	To discontinue	570	275	295
Mosjōen	To continue	619	317	302
Total, 9 samlags 4 to continue, 5 to discontinue		45,197	21,437	23,760

The result for this year is therefore not quite as unfavorable to the samlags, the percentage of votes for and against their continuance standing in the ratio of 474 : 526. May not this be taken as an indication of at least a slight dissatisfaction with the effects produced by the discontinuance of the eleven samlags in the previous year? But passing to the year 1897 let us see in what direction public opinion is tending.

Balloting in 1897.

Cities.	Result.	No. of voters.	No. for samlags.	No. against.
Fredrikshald	To continue	5,482	3,165	2,317
Sarpsborg	To discontinue	2,052	938	1,114
Hamar	To continue	2,115	1,516	599
Kongsberg	To continue	2,456	1,635	821
Drammen	To continue	9,457	6,493	2,964
Holmestrand	To continue	1,088	726	362
Horten	To continue	3,583	1,916	1,667
Larvik	To continue	4,857	2,487	2,370
Porsgrund	To discontinue	2,138	943	1,195
Kristiansund	To discontinue	5,914	2,595	3,319
Tromsō	To continue	2,842	1,852	990
Total, 11 samlags 8 to continue, 3 to discontinue		41,934	24,296	17,718

The sentiment against the samlags is evidently growing weaker. This year the percentages for and against their continuance stand in the ratio of 58 : 42.

The result in the year 1898 as shown by the following table is not much different:

Cities.	Result.	No. of voters.	No. for samlags.	No. against.
Fredrikstad	To discontinue	6,153	2,677	3,476
Moss	To continue.....	3,582	1,997	1,585
Lillehammer	To continue.....	1,272	774	498
Hönefos	To continue.....	806	464	342
Svelviken	To continue.....	609	387	222
Sandefjord	To discontinue.....	2,265	938	1,327
Kragerö	To discontinue.....	2,578	662	1,916
Kristiansand ...	To continue.....	6,396	3,325	3,071
Flekkefjord	To discontinue.....	1,040	313	727
Egersund	To continue.....	1,476	829	647
Trondhjem	To continue.....	16,829	12,812	4,017
Hammerfest	To continue.....	977	677	300
Total, 12 samlags 8 to continue, 4 to discontinue.....		43,983	25,855	18,128

Again reckoned in percentages the number of votes for and against the samlags here stands in the ratio of 588 : 412. The percentage of votes against the samlags is thus found to be smaller in 1898 than in any of the preceding years when ballots were taken.

Now taking all years together we find that out of forty-five cities, twenty-three have done away with the samlags, have, in other words, abolished the Gothenburg system and substituted in its place prohibition. Our next problem, therefore, will be nothing less interesting than a comparison of prohibition as it has operated in these cities during later years, with the Gothenburg system as it operated in the same cities previously, and as it is operating in other cities during the years prohibition has been in vogue.

Has prohibition proved to be a greater factor in the decrease of drunkenness than the Gothenburg system? The solution of this problem offers the best of criteria for judging the relative merits of the two systems. Of course, it is evident that in this

solution we must deal with the two systems not as they might be pictured in ideal theories but as they practically exist,—as they are and have been operating in Norway now and during recent years.

Since in prohibition towns a knowledge of the amount of liquor disposed of, or consumed, is not attainable through any statistical records, we must proceed in the rather indirect way of judging the extent of inebriety by the number of arrests for drunkenness, a record of which is obtainable through the statistical reports of the nation. Taking this as our basis then, let us first ask whether there has been a greater or smaller number of such arrests since the discontinuance of samlags in the respective cities where balloting has taken place. In regard to the cities where as a result of the election of 1895 samlags were discontinued from January 1, 1896, the following table will answer our inquiry by showing the number of persons reported as arrested for drunkenness:

Number of arrests for drunkenness.

Cities.	Population.	1892.	1893.	1894.	1895.	1896.	1897.
Namsos	1,840	7	8	13	37	18	33
Molde	1,629	47	24	42	26	49	54
Aalesund	8,406	147	184	224	176	204	214
Grimstad	3,173	87	74	62	75	83	131
Arendal	4,578	313	291	239	296	350	260
Risör	3,148	50	54	51	55	69	58
Brevik	2,073	52	90	87	88	38	33
Tönsberg	7,215	425	492	503	497	483	633
Aasgaardstrand	398	—	—	6	6	9	23
Gjövik	1,416	—	154	132	122	128	321
Total	33,876	1,128	1,371	1,359	1,378	1,431	1,760

From this table alone we must infer that drunkenness has not been decreasing but rather increasing in these cities since the discontinuance of the samlags. That being our inference, we again ask: What are the records in regard to the number of similar arrests for the same time in cities where samlags con-

tinued in operation? The following table of ten such cities that are approximately of the same population as the above will afford material for the necessary comparison:

Number of arrests for drunkenness.

Cities.	Population.	1892.	1893.	1894.	1895.	1896.	1897.
Stenkjaer	1,893	37	19	31	25	74	58
Tvedestrand	1,759	48	35	29	32	29	41
Ekersund	2,960	70	99	121	80	102	130
Holmestrand	2,356	53	71	94	57	62	108
Lillehammer	1,832	251	199	210	127	117	140
Konsvinger	1,310	58	28	72	29	37	59
Kristiansund	12,813	412	919	497	526	755	909
Stathelle	373	1	1	4	4	2	10
Hönefos	1,494	76	159	158	210	276	225
Horten	6,813	130	150	190	161	209	319
Total	33,603	1,146	1,680	1,406	1,251	1,663	1,999

These cities where samlags have continued to operate thus show an increase in the number of cases of drunkenness since 1895, approximately the same as the increase in the preceding cities where samlags have been discontinued.

Before inquiring into the causes of this increase, especially of this paradoxical increase in the cities that have adopted prohibition, let us also consider whether arrests have taken the same direction in the cities where samlags were discontinued from the first of January, 1897.

Number of arrests for drunkenness.

Cities.	Population.	1892.	1893.	1894.	1895.	1896.	1897.
Stavanger	23,899	630	515	535	561	786	885
Sogndal	470	3	1	3	4	1	0
Farsund	1,648	12	7	12	14	10	2
Lillesund	1,508	7	37	41	40	23	50
Levanger	902	25	31	36	25	35	41
Total	28,427	677	591	627	664	855	978

The same tendency is evident here. That there should be an increase in drunkenness in cities still possessing samlags might not seem unnatural, but that the cities that did away with samlags and began a regime of prohibition should show such a marked increase seems indeed surprising. How can it be accounted for? None of these cities have had legalized sales of spirituous drinks by private individuals. They have only had legitimate dealers in the milder drinks. An explanation of the increasing drunkenness, therefore, resolves itself into a discussion of the following three possibilities. Has drunkenness been due (1) to smuggling in the stronger drinks, (2) to a purchase of drinks from the neighboring samlags, or (3) to an increased traffic in the milder drinks?

In regard to the first possibility the following tables, designed to show the number of cases of arrests for illegitimate liquor selling during each of the more recent years will answer.

In the cities where samlags were discontinued from January 1, 1896:

Number of arrests.

Cities.	1892.	1893.	1894.	1895.	1896.	1897.
Namsos	2	0	0	0	2	0
Molde	0	0	0	0	0	0
Aalesund	3	0	2	1	1	1
Grimstad	0	0	1	0	0	0
Arendal	1	0	0	1	1	0
Risör	0	0	1	0	1	4
Brevik	5	7	3	3	0	0
Tönsberg	2	0	3	2	1	1
Aasgaardstrand	0	0	0	0	0	0
Gjövik	0	0	0	0	0	0
Total	13	7	10	7	6	5

In the cities where samlags were discontinued from January 1, 1897:

Number of arrests.

Cities.	1892.	1893.	1894.	1895.	1896.	1897.
Stavanger	1	2	3	4	3	3
Sogndal	1	1	1	1	1	0
Farsund	1	0	1	1	1	0
Lillesund	0	0	0	0	0	0
Levanger	0	0	0	0	0	0
Total	3	3	5	6	5	3

As seen from these tables the city of Risör forms the only exception to the otherwise universal tendency that the number of arrests for illegitimate sales has not increased but, if changed at all, has decreased.

Nevertheless, before dismissing from our discussion the assumed possibility that the increase of drunkenness may be due to illegal traffic in brandy there are two reasonable inquiries which must be answered. First, how far is the number of arrests for the illicit sale of liquor a true criterion for the extent to which it is carried on? Secondly, has there since the discontinuance of the samlags been any change in the stringency of the laws against such crimes or in the vigilance of the police in enforcing the laws?

In regard to the first inquiry it may be said that Norway, unlike the United States, has been very successful in suppressing illegal liquor selling. Besides the pressure of public opinion and the weight of civil and moral obligation, there are two reasons why the police of Norway are especially active in arresting the illicit liquor dealer and the drunkard. The first of these is the fact that the police officer who arrests any offender against the liquor law receives one-half of the fines imposed if the person whom he arrests is found guilty. The second is the further fact that if the police does willingly, carelessly, or fraudulently allow any offender against the liquor law to escape being arrested, the police officer himself becomes liable for one-half of the fines which would have been imposed upon the of-

fender. These two factors,—the first encouraging the police with an incentive towards financial gain, the second confronting him with the fear that if he shirks his duty or enters into fraudulent agreements with saloon-keepers he will himself be visited with punishment,—create (1) a competition among the police, and (2) a scrupulous attention to duty. Under these conditions it is hardly possible that the illicit dealer or any other offender against the liquor law can escape his doom. The number of arrests as shown in preceding tables must therefore be a tolerably true criterion of the amount of illegal traffic in liquor actually existing.

Our second inquiry now needs but little discussion. Mr. Aarestad, who is undoubtedly the highest authority on the liquor problem of Norway and who has thoroughly investigated the material relevant to a consideration of this inquiry, says in his reports,—and with him the police themselves of the various cities agree,—that, in general, the conditions under which arrests for breaches of the liquor law have taken place have remained practically unaltered during the last few years. In speaking of the arrests for illicit liquor selling, he says: "There is no reason for believing that the police have not been just as ingenious and careful in arresting illicit dealers since the discontinuance of the samlags as they were before."

It being established then that even in the cities where samlags have been discontinued drunkenness continues, and that the cause of this drunkenness cannot be attributed to illegitimate liquor selling, we next have to inquire whether these cities patronize neighboring samlags. It does of course seem natural that just as soon as samlags were discontinued in a city some of the inhabitants of that city, especially those who voted for a continuance of the samlags, would buy spirituous drinks from the samlags still operating in neighboring cities. The only way by which we can find out whether this is what has actually happened, is to ascertain whether or not the records of the neighboring samlags show much greater sales after the discontinuance of samlags in other places than before such discontinuance. The following tables are designed to give the necessary information by showing the last year's sales by the

samlags discontinued from January 1, 1896, and the sales by the neighboring samlags for two years following and for three years preceding:

Samlags discontinued.	Sales of same in 1895.	Neighboring samlags.
Gjövik	40,000 litres	Lillehammer. Hamar.
Aasgaardstrand	8,962 litres	Holmestrand.
Tönsberg	81,140 litres	Horten. Sandefjord.
Risör	20,722 litres	Kragerö.
Arendal	64,041 litres	Tvedestrand.
Grimstad	27,993 litres	Kristiansund.
Brevik	13,000 litres	Porsgrund. Langesund.
Aalesund	30,647 litres	Bergen.
Molde	19,064 litres	Kristiansund.
Namsos	25,690 litres	Trondhjem. Stenkjar.
Total	331,259 litres	

Sales of the neighboring samlags.

Number of litres.

	1893.	1894.	1895.	1896.	1897.
Lillehammer	64,105	52,725	45,379	55,367	63,623
Hamar	68,245	61,772	54,964	72,248	86,913
Holmestrand	30,730	30,336	27,257	25,623	27,438
Horten	40,412	37,013	37,767	42,668	44,948
Sandefjord	38,316	37,549	34,261	32,790	34,108
Kragerö	44,372	42,331	36,884	32,747	36,767
Tvedestrand	18,661	17,873	16,678	20,361	21,330
Kristiansund	160.649	136,371	130,529	125,018	116,236
Porsgrund	32,202	32,258	29,209	28,936	35,338
Langesund	8,596	6,871	6,486	5,067	4,988
Bergen	338,485	319,719	301,951	294,025	351,059
Kristiansund	66,600	59,125	57,420	81,112	86,978
Trondhjem	365,829	316,561	285,894	322,892	379,586
Stenkjaer	24,174	23,286	21,376	23,101	30,559
Total	1,311,376	1,173,840	1,086,055	1,161,955	1,320,371

From the beginning of 1896 to the close of 1897 there was a rise of 234,316 litres in the amount of sales by samlags whose traffic we should expect to be affected by the discontinuance of the samlags voted down in 1895. We must not at once, however, infer that this rise is due entirely to the patronage of neighboring cities. Another factor, before mentioned, must be taken into consideration here, the fact, namely, that by the new law that went into effect January 1, 1896, the wholesale traffic was materially altered. Previously, as we saw, the wholesale merchants were free to sell in as small quantities as twenty litres. Now by the new law they were limited to sell in quantities not less than two hundred and forty litres and were besides obliged to pay a license of at least one thousand krowns. As this change practically did away with all direct trade between consumer and wholesaler, which (previous to the new law) had been quite appreciable, we must attribute the rise in the sales of the neighboring samlags, as shown in the preceding table, to the transfer from the wholesale merchants to the samlags of approximately that amount of liquor which before 1896 consumers had purchased directly from the former. There seems, therefore, to be no reason for believing that the cities where the Gothenburg system has been discontinued have, to any noticeable extent, patronized the samlags of neighboring cities.

To further substantiate this conclusion I present another table showing the rise in sales by samlags so located that by their very position it would be absurd to believe that they had gained anything by the discontinuance of any of the samlags abolished by the vote of 1895.

Amount of sales in litres.

Cities.	1893.	1894.	1895.	1896.	1897.
Bodö	33,072	25,919	28,189	33,095	36,810
Tromsö	50,460	46,126	39,672	61,014	60,376
Hammerfest	26,640	26,175	23,600	32,573	31,349
Vadsö	18,369	23,792	17,355	26,069	20,553
Vardö	18,785	22,190	17,713	33,365	20,845
Total	147,326	144,202	126,529	186,116	169,933

Thus, we see that these cities around which no samlags have been voted down have also had considerably larger sales in the years following 1895 than they had before. Comparing the total increase of sales at the samlags of these two different classes of cities we obtain the following significant data:

Total sales.

	1895.	1897.	Percentage of increase from 1895—1897.
By adjacent samlags	1,086,055	1,320,371	.2157
By distant samlags	126,529	169,933	.343

We here have a direct proof that the sales have increased more at the samlags that are far away from the cities where samlags have been discontinued than at the samlags that are near such cities. As no special conditions exist that would increase the sales at one place more than at another, it seems to me that we cannot avoid the conclusion that cities that have discontinued their own samlags have not, at least not to any large extent, patronized neighboring samlags.

Having now shown that the continued drunkenness in the prohibition towns is due neither to illegitimate sales of spirituous liquors nor, to any large extent, to the purchase of these liquors from neighboring samlags, we have only one of the three assumed possibilities left. Is the continued drunkenness due to an extraordinary sale of ale and wine? Yes, this is the only conclusion to which an impartial study of the question can lead. As the samlags never possessed exclusive control over other than the spirituous liquors, it is evident that their discontinuance would not stop the selling of ale and wine. Naturally we should expect a greater sale of these milder beverages. When one avenue is closed the other becomes doubly crowded. When the samlags, and with them the sale of spirituous liquors, were done away with, ale and wine, especially "Ladde vin," took their places. We need not here consider the injurious hygienic effects of ale and wine as compared with spirituous liquors. By the tables of arrests it is only too evident that they must have

been lavishly consumed. At present ale and wine are sold by almost every local merchant. A license which according to law cannot exceed $107.20 and which is nearly always much lower is entirely too small to put any reasonable limit to the number of ale and wine houses. Drinking is thus made very easy, and consequently is very largely indulged in. It is, however, not only in the cities that have abolished samlags that this kind of drinking has increased. It has found its way into samlag and prohibition towns alike. Ale and wine have become more and more fashionable in later years. Vast breweries have been erected and more are in the process of erection every year. More and more wine, too, is being imported. Norway to-day need fear not so much the brandy as the milder drinks. While the retail and bar trade of the former in cities licensed for its sale is under the absolute control of samlags (Christiania and Skien excepted) and it is sold only under strict regulations, the trade in the latter, which is conducted by private individuals who pursue the business for private gain, is practically free from all restrictions.

That this laxity with regard to the sale of these milder beverages is an evil which ought to be remedied is unquestionable, but the problem how to remedy it is more difficult than is apparent. It might seem that it would be an easy matter for Norway to allow the samlags to assume exclusive control over the sales of all kinds of liquor, and, indeed, it may seem strange that she, face to face with the danger of being flooded by these beverages, has not made provisions to that effect already; but here, as generally in all matters of reform, there are obstacles in the way. Unfortunately, as a result of earlier liquor legislation there still survive several hundred licensed merchants who, according to the law of contract, hold unassailable rights to trade in ale and wine as long as they live. As long as these private saloons continue the traffic, there is little hope for improvement. The samlags being governed by strict rules, are from the very nature of their organization unable to compete with other establishments whose sales are bound by no regulations other than those desirable from the point of view of private gain. If the samlags have not exclusive control, then, as far as the fostering of sobriety is concerned, they might almost as well have no con-

trol at all. The step preliminary to granting samlags exclusive control in the sale of ale and wine is therefore to dispose, in some way, of the rights now held by the privileged merchants. And rather than await the course of nature to do away with these, a process which would still take from three to seven decades, the Norwegian people, through a special committee appointed by parliament to consider plans for reforming the liquor law, are now ready to advocate that these vested rights be abrogated by means of expropriation. It is hoped that for a reasonable sum the merchants will relinquish their rights. If this is done and all rights are transferred to samlags then there is every reason to believe that the sales of ale and wine will, like the sales of brandy, be greatly diminished. To achieve this expropriation is therefore the next and necessary step in the further development of the temperance movement in Norway.

There is therefore no criticism to offer against the Gothenburg system other than that it has now reached a point in its history where operating according to its past principles alone it is no longer adequate to foster to a higher degree the sobriety of the Scandinavian people. The necessary change, however, will not be a change in the fibre of the system. The new system of absolute control of all intoxicants by samlags will simply be the Gothenburg system completely realized.

The realization of this absolute control by samlags must not, however, mean that the samlags shall necessarily sell all sorts of liquors. It would indeed be the height of inexpediency and directly inconsistent with the aim of the system were it to propose a resumption of the brandy traffic in cities where that traffic can be prohibited. Total prohibition must be recognized as the goal of all ideal liquor legislation. The samlags should sell only those beverages which the public opinion of the community may sanction, and which if not sold by samlags would fall under the control of private greed for gain. Absolute control and the smallest possible sales,—such is the new Gothenburg system demanded by the present stage in the evolution of the Scandinavian liquor problem.

The purpose of the Gothenburg system is to do away (1) with the evil influences of the individual greed for gain, (2) with the reckless impoverishment of the poor through drinking on credit

or pawn tickets, (3) with the injury arising from the sale of liquor to young people, (4) with the violation of restrictive regulations of the law in regard to hours of sale, to the quantities allowed to be sold, and to the entire management of the business, (5) with a competition which lowers the prices, (6) with the use of an unnecessarily large number of licenses, and finally (7) with the evil influence of the saloon as an element in political life. When the system has been extended to the sale of all alcoholic beverages, it will, by virtue of its many excellences, exert a blessed influence upon the future.

In order that the results at which we have arrived may not be deemed inharmonious with the opinion of authorities who have studied the Gothenburg system not from a distance, as we have been obliged to do, but who have studied it in the very theatre where the drama has been played, I shall, in conclusion, present a few quotations to indicate that at least a few prominent Scandinavian authorities agree with my conclusion. Says Sven Alarestad, to whom we have already referred as a leading authority: "The same reasons which have made it desirable that the traffic in brandy should be controlled absolutely by samlags make it also desirable that ale and wine should be thus controlled. Especially is absolute control by samlags desired in the traffic in the cheap and highly intoxicating wines which have become so common during later years. These wines seem indeed to be even more intoxicating than brandy. But it is also desirable that samlags should be granted absolute control of the sales of ale. It is evident that the brewers are more and more gaining control of those channels through which ale may reach the people. All liquor traffic should be controlled by samlags." Says Siegfrid Wieselgren, the president of the Swedish Temperance Society: "Under the present state of things it seems to me it would be a very wise measure to extend the application of the system by bringing under its control also the sale of the milder liquors." Says H. E. Berner, the noted temperance advocate and mayor of Christiania: "There can be no doubt that by granting absolute control of the sales of all liquors to samlags we should see a material decrease in the amount of drunkenness, and a new and great triumph for temperance work."

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Madison, Wis.

SOME PSEUDO HISTORIES OF THE AMERICAN REVOLUTION.

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Wm. Gordon's History of the American Revolution (London, 1788), has just been proved to be a complete plagiarism.[1] In spite of its long established reputation and the praise of well known critics, there can be no doubt of the spurious nature of Gordon's claims to be either an accurate or a truthful writer. But his history was by no means the only plagiarism of the material in the English Annual Register. No less than six distinct histories of the Revolution, four of them anonymous, appeared and passed current in the decade preceding the appearance of Gordon's well known work. The first in order is Russell's History of America.[2] This work borrows from the Annual Register in part of its account of the French and Indian War, especially in the attack upon Quebec. The appendix is mostly a well adapted plagiarism from the Annual Register, beginning with a complete theft of the account of Pontiac's War. The account of the Revolutionary War ends with Feb. 6, 1778, and is an irregular copy of the Annual Register, skilfully put together, however, and shows on Russell's part a good appreciation of the strong points in the original. A few parallel readings will reveal the nature of the plagiarism.[3]

"The fortunate termination of this war which not only restored tranquility to our American empire but seemed to es-

[1] Publications American Historical Association, I., 365–388.

[2] Wm. Russel, Esq., Gray's Inn: The History of America from its Discovery by Columbus to the conclusion of the late war, with an Appendix containing an account of the Rise and Progress of the Present Unhappy Contest between Great Britain and Her Colonies. 2 Vols. London. 1778.

[3] Annual Register, 1765, pp. 50 and 55, 1774, p. 45; Russell, II., 421 and 433; Russell, II., 457.

tablish it on a more solid foundation than formerly, revived in the minds of the colonists the idea of independency: and which might otherwise have remained for years in contemplation; and at length perhaps have proved no more than an amusing theory."[1 2 3]

From this initial sentence these three histories to which reference is made in the note run exactly parallel with hardly the variation of a word through pages 425–57, 45–102 and 3–69 respectively, in the order named. From this point the second and third part company with Russell to pursue each a separate development.

We may next consider a fourth history of the Revolution[4] and trace its connection with the others. This history is divided into two parts of which part first has three chapters.[5]

The first chapter deals with the discovery of America,

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[1] Russell's History of America, II., 425.

[2] An Impartial History of the War in America between Great Britain and Her Colonies from its Commencement to the end of the year 1779, exhibiting a circumstantial, connected and complete account of the real Causes, Rise and Progress of the War, interspersed with Anecdotes and Characters of the different Commanders and Accounts of such Personages in Congress as have distinguished themselves during the contest. With an appendix containing a Collection of Interesting and Authentic Papers tending to elucidate the History. Illustrated with a variety of beautiful Copper Plates, representing real and animated Likenesses of those celebrated Generals who have distinguished themselves in the important contest. London, 1780. Printed for R. Fauldner, New Bond Street.

Page 45, ch. I. The History of the Origin, Rise and Progress of the Civil War in America.

[3] The History of the Origin, Rise and Progress of the War in America between Great Britain and Her Colonies, from its Commencement in the Year 1764 to the time of General Gage's Arrival at Boston in 1774. London, Printed.

Boston, in the State of Massachusetts. Reprinted by Thomas and John Fleet at the Bible and Heart in Cornhill. 1780.

Page 3, ch. I. The History of the Origin, Rise and Progress of the War in America.

[4] The History of the War in America between Great Britain and Her Colonies from its commencement to the end of the Year 1778. In which its Origin, Progress and Operations are faithfully related, together with Anecdotes and Characters of the different Commanders and Accounts of such Personages in Congress as have distinguished themselves during the Contest. To which is added a Collection of Interesting and Authentic Papers tending to elucidate the History. In two volumes. Dublin. Printed for the Company of Booksellers. 1779.

[5] Part I. A General History of America from its first discovery to the Commencement of the present Civil War.

Spanish conquest in Mexico and Peru and gives also a general account of the New World, including a description of the Indians. Chapter second gives an account of North America and the West Indies and the last chapter discusses the British colonies. This part of the work contains a large map illustrative of the general features of the eastern half of the present United States. In the London edition just referred to this same material and its exact arrangement all reappear without the omission of a chapter heading or a misspelled word.

In part second these editions diverge widely in title[1] and contents. The Dublin edition uses its own summary in tracing the course of events while the London edition follows Russell till the incident of the burning of the Gaspe is reached. Then the two editions coalesce once more not to diverge again till the defeat of Burguoyne in 1777, on pages 312 and 499 respectively. From that point the Dublin edition is a mere summary of facts drawn from the Annual Register while the London edition copies from the same source with only slight abridgment or omission.[2] We may now recur to the Boston edition of 1780 (Impartial History) and take up its evolution. It has already been pointed out that this work from pages 3–69 was copied from Russell's history. From this point to the end of part first it is parallel to the London edition. Here, however, the work takes a new title[3] and the remainder of the volume is a mere copy of the Annual Register,[4] without reference to the copies from the same source in the London edition. A careful examination of these editions with their source will show this conclusion to be correct.[5]

Volume II is composed largely of material from the London

[1] London Edition. Part II. The History of the Origin, Rise and Progress of the Civil War in America.

Dublin Edition. Part II. The History of the Civil War in America.

[2] On the fly leaf of the copy in the Harvard Library is the following remark by Jared Sparks: "The part of this volume which relates to the American war is selected verbatim from the Annual Register."

[3] The History of the Rise and Progress of the War in North America from the time of General Gage's Arrival at Boston in May, 1774.

[4] Compare the material with that of the Annual Register of 1775, p. 1.

[5] In one of the copies of this work in the Boston Public Library some one has made a note regarding the preface to the effect that it is copied from the Annual Register.

edition[1] though there are some portions of the first chapter copied from the Dublin edition.[2]

These four histories thus form a group intertwined in such a way that it is extremely difficult to ascertain in many cases which is original and which copy. But of this we may be certain that for the Revolutionary struggle the Annual Register was the source for most if not all of the material to be found in these works.

Murray's history of the Revolution[3] next claims our attention. It is a very inferior work and was written with the Annual Register as a constant source. A single parallel quotation will serve to show how he plagiarized.

Annual Register, 1765, p. 24: "It could not, surely be expected that merely out of a compliment to the mother country they submit to perish for thirst with water in their own wells. They suffered enough, as it was, by being obliged to make bricks without straw; to carry on manufactures and trade without either metal or paper money to facilitate the course of them."	**Murray, I., 18. "It was a thing not at all to be expected that the colonies out of mere compliment to Great Britain should submit to perish for want of the necessaries of life, when they had a great abundance within themselves. Their sufferings already were of the severest sort; for like the children of Jacob in the land of bondage, they were required to make brick without straw;— to carry on trade and manufactures without either money or paper currency to promote their course."**

In affairs out of America, Murray copies his accounts likewise from the Annual Register, as in the description of the Caribs of St. Vincent.[4] That which really distinguishes Murray's history from all the others and gives it a bad preeminence is his vicious habit of commenting upon his stolen material. He never has anything original to say and some of his explanations are grotesque enough to merit a place in Gulliver's

[1] Chapters XVIII. and XIX. (London Edition.)

[2] Pages 335–336. (Dublin Edition.)

[3] Impartial History of the Present War in America, containing An Account of its Rise and Progress, the Political Springs thereof, with its various Successes and Disappointments on Both Sides. 3 vols. By the Rev. Jas. Murray, Newcastle upon Tyne.

[4] Ann. Reg., 1773, p. 83 ff. Murray, I., 349–368.

Travels.[1] A few samples will suffice to illustrate his predominant weakness.

Speaking of the flour destroyed by the soldiers at Concord:—

"About a year after, that flour would have been of some service to the same troops, when they were cooped up in Boston. It argues a great malignity of temper to destroy the bounties of providence for fear that our enemies should enjoy them."

In describing the retreat he makes the following original comment:—"They were now in a very critical situation and much distressed, which evils they had brought upon themselves by their rashness in shedding blood when they had no occasion."[2]

Again in commenting on the British treatment of the Caribs of St. Vincent Island he says:—"In spite of all the thick daubings of falsehood and the fair strokes of flattery, the vile complexion of the men and their measures will appear to the view of impartial observers. Ages to come will stand amazed when they read in the annals of Britain that in an aera of liberty, and under the government of a pious and religious sovereign, such unjust and arbitrary proceedings should have been carried on."[3]

Perhaps the worst example of all is the following reference to the killing of Jane M'Crea:—"This tragedy will stand as a deep blot in the annals of the present government as long as the sun revolves in his course around this terrestrial globe. This massacre, and others its concomitants, will in some future reckoning make that coward tremble who is said to have given it sanction by the authority of his master on this side of the Atlantic; and that hero who boasted great things in his sanguinary proclamations will find the ghosts of innocents haunt him when the weapons of warfare are buried in peace."[4]

No one will doubt after reading these quotations that Murray has a style and that his rhetoric is consistently bad. There is a unity of method and a certain unvarying senility in the way he dilutes his modicum of fact with a flood of platitudes.

Winsor's treatment of Murray is peculiar and lays the great

[1] Murray, II., 183. An explanation is here given of the true reason for the inadequate stores at Fort Washington at the time of its capture by the British.

[2] Murray, I., 441 ff.

[3] Ib., I., 354.

[4] Ib., II., 320-321.

bibliographer open to the charge of not carefully examining his materials before pronouncing judgment. In regard to the Wyoming massacre he says, "I should be strongly inclined to quote here from the pages of Murray's Impartial History of the present War, etc., to show that British opinions were as strongly pronounced in their expressions against the reported acts of Butler and that they held the authorities who permitted him to bear a commission responsible, were it not that I find so many pages in this book identical with *An Impartial History of the War in America*, which was published about the same time in Boston, that I am at a loss to determine which was the original book. The two books are not in all respects the same. The one purports to be an English composition; the other an American recital. Phrases in which the enemy are alluded to in the one are reversed in the other, while topics which are elaborated in one are barely mentioned in the other; still there are enough pages identical in the two, except for the toning down of the adjectives to make me doubtful of the authorship of the Rev. James Murray."[1] Further, he says: "Another work of similar title, credited to the Rev. James Murray, shows a decided affinity to the side of the rebels, though as a hurried compilation, there is some mixture in its views."[2]

"It is in fact, as Mr. A. M. Davis tells me after making a comparison, to about the extent of three-quarters merely a reprint of the text of the Boston edition, with some verbal changes."[3]

The history Winsor refers to as the original source for Murray's is one published in Boston in 1781.[4] In the one-volume

[1] Winsor, VI., 663. Note 4.

[2] Ibid., VIII., 500.

[3] Ib., VIII., 500. Note 7.

[4] An Impartial History of the War in America between Great Britain and the United States from Its Commencement to the end of the war. Exhibiting a circumstantial, connected and complete account of the real Causes, Rise and Progress of the War, interspersed with Anecdotes and Characters of the different Commanders, and Accounts of such Personages in Congress as have distinguished themselves during the Contest. With an Appendix containing a Collection of Interesting and Authentic Papers, tending to elucidate the History. Illustrated with beautiful Copper Plates. 3 vols. Boston. Printed by Nathaniel Coverly and Robert Hodge at their office in Newberry St., 1781.

Vol. III is entitled: The History of the War in America. Containing an Account of its Rise and Progress with its Various Successes and Disappointments on both sides. Boston. Printed by Nathaniel Coverly in Newbury Street, No. 53, near the sign of the lamb. 1784.

edition the events are carried to the close of 1776 while in the three-volume edition they end in 1783. The first three chapters of this work are identical with those of the Dublin edition of 1779. The larger part of the work is a copy from Murray until the close of Burgoyne's campaign. From this time on the Annual Register is used.

The only remaining question is concerning Winsor's statement that Murray's history is but a copy of the foregoing. In the first place this Boston work was published in 1781, at least three years after the former appeared. Then when we recall Murray's pretentious style it becomes perfectly obvious that it could not belong to an anonymous writer. Its very pose and strut forbids the notion of concealment—such an author would wish to proclaim his work from the housetops. Furthermore, Murray's peculiar style continues throughout his work from the preface to the conclusion. But the Boston edition of 1781 ceases to show Murray's style after the account of Burgoyne's campaign. It is a polyglot affair at best, drawn from three sources, while Murray's history never varies in its make up and shows traces of but one origin.

From the Annual Register have arisen, therefore, seven histories of the American Revolution, four of which are anonymous. Of these four the Dublin edition of 1779 is the only one that can make any claim whatever to originality in any part, since it furnished the opening chapters for two other histories, the London edition of 1780 and the Boston edition of 1781. As a means of comparing the different forms of plagiarism employed by the compilers of these works, the account of the incident of the Hutchinson Letters affords a very fair example.[2]

But one other consideration remains for discussion. The clearing away of the accumulated rubbish of a hundred years brings the Annual Register prominently forward as an original authority of high value for the American Revolution. It becomes important for us to know, therefore, more certainly than at present, who contributed the articles in the Annual Register and from what sources they were drawn. As the subject is an intricate one, involving questions of internal as well as of external evidence, it may well remain for a later treatment.

[1] Vol. II., 325.

[2] Gordon, I., 328–330; Russell, II., 457–458; Murray, I., 392–394; Dublin Edition, I., Part II., 4; Annual Register, 1774, p. 46, ch. 1.

TRANSACTIONS

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ON THE ERRORS WITH WHICH LOGARITHMIC COMPUTATIONS ARE AFFECTED.*

By Carl Bremiker, Ph. D.

INTRODUCTION.

The original of the following dissertation on the errors of logarithmic computation appeared in 1852 as an introduction to the first edition of Bremiker's six place tables. The great excellence of the paper has led many students of mathematics to read it, in spite of the fact that the edition of Bremiker's tables which contains it is quite inaccessible, and although the difficulties are further increased because the original is in Latin.

Mr. P. E. Doudna wrote out a translation of the paper in 1894–95, at which time he was holding a fellowship in applied mathematics in the University of Wisconsin. Mr. Doudna's failing health required him to remove to Colorado, where he died in February, 1900. Mr. E. F. Chandler, who was fellow in applied mathematics in the University of Wisconsin in 1898–99, wrote out, at my suggestion, an independent translation of the paper. He was furnished with a copy of Mr. Doudna's translation in order to verify his work. We deeply regret that Mr. Doudna was not able to go over the present translation before its publication, as his judgment would have been of great value. It has seemed right, however, that the translation should appear under their joint names.

*Translated by P. E. Doudna A. M., late Asst. Professor of Mathematics in Colorado College, and E. F. Chandler, A. M., Instructor in Mathematics in the University of North Dakota.

Mr. Chandler has recomputed all of the tables and illustrative numerical examples given by Bremiker. A few corrections are indicated in the foot notes. No changes have been made at any point except the correction of palpable misprints and the insertion of the numbers attached to the principal equations and formulas to facilitate reference.

CHAS. S. SLICHTER.

Madison, April, 1901.

CONCERNING THE ERRORS BY WHICH LOGARITHMIC COMPUTATIONS ARE AFFECTED.

§ 1.

Since the exact value of any logarithm is in general an incommensurable number, which can not be expressed except by an infinite number of decimal figures, and since in the logarithmic tables only the first decimal figures are given, which we use in computation instead of the exact value, it is evident that a result obtained by the use of logarithms is affected by a greater or less error. But whenever we are willing to use in the computation more decimal places than are called for by the accuracy of our data, this error arising from the inaccuracy of the logarithms may be disregarded, in comparison with that which arises from the inaccuracy of the data. If, however, in order to save useless labor, only as many decimal figures be used in the computation as are called for by the accuracy of the data, then it will be proper before the computation is commenced to consider the theory of the errors which can arise from the omitted decimals. The discussion of this theory which is attempted below will show whether five, six, or seven decimals ought to be used in the computation.

§ 2.

First, assume that the errors of all the logarithms used in the computation (i. e. their true values) are known. Then by the aid of the differential calculus the error of their resulting sum can easily be found. For this it is sufficient to use only the first differentials, since, in comparison with the true values of the logarithms, the errors can be regarded as infinitesimals, whose higher powers are of no weight in the computation. In this computation the following equations may be used:

$$\left.\begin{aligned} d(\log x) &= \frac{dx}{x} \\ d(\log \sin x) &= \cot x.\, dx \\ d(\log \cos x) &= -\tan x\,.\,dx \\ d(\log \tan x) &= \frac{2}{\sin 2x}\,.\,dx \\ d(\log \cot x) &= -\frac{2}{\sin 2x}\,.\,dx \end{aligned}\right\} [1]$$

Furthermore, the manner in which the errors of the number a and of the arc A are connected with the errors of the Briggs logarithms is shown by the following equations:

$$\left.\begin{aligned} f(\log a) &= \frac{m}{a} f(a) + f' \\ f(\log \sin A) &= \frac{m}{r} \cot A\, f(A) + f' \\ f(\log \cos A) &= -\frac{m}{r} \tan A\, f(A) + f' \\ f(\log \tan A) &= \frac{2m}{r \sin 2A} f(A) + f' \\ f(\log \cot A) &= -\frac{2m}{r \sin 2A} f(A) + f' \\ f(a) &= \frac{a}{m} \cdot \left\{ f(\log a) - f' \right\} \\ f(A) &= \frac{r}{m} \tan A \cdot \left\{ f(\log \sin A) - f' \right\} \\ &= -\frac{r}{m} \cot A \cdot \left\{ f(\log \cos A) - f' \right\} \\ &= \frac{r}{2m} \sin 2A \cdot \left\{ f(\log \tan A) - f' \right\} \\ &= -\frac{r}{2m} \sin 2A \cdot \left\{ f(\log \cot A) - f' \right\} \end{aligned}\right\} [2]$$

where an f indicates the error accumulated in computation and transferred from the logarithm to the number or arc, or from the number or arc to the logarithm, and f' denotes the error of a logarithm taken from the table; $m = 0.43429$ is the modulus of the Briggs system and $r = 206265$ is the length of the radius expressed in seconds of arc.

These equations, if applied to any logarithmic computation whatsoever, show the error of the final result as a linear function of the separate errors. To illustrate this, take as an example the equation

$$\sin^2 \tfrac{1}{2}c = \sin^2 \tfrac{1}{2}(a-b) + \sin a \sin b \sin^2 \tfrac{1}{2}C$$

which expresses the third side c of a spherical triangle in terms of the given sides a and b and the included angle C. First compute

$$\cot \mu = \frac{\sin \tfrac{1}{2}C \sqrt{\sin a \sin b}}{\sin \tfrac{1}{2}(a-b)},$$

then

$$\sin \tfrac{1}{2}c = \frac{\sin \tfrac{1}{2}C \sqrt{\sin a \sin b}}{\cos \mu}.$$

Then if the errors of the logarithms of the table are arranged in order,

in	$\sin \frac{1}{2}C$	the error	f_1
"	$\sin a$	" "	f_2
"	$\sin b$	" "	f_3
"	$\sin \frac{1}{2}(a-b)$	" "	f_4
"	$\cot \mu$	" "	f_5
"	$\cos \mu$	" "	f_6
"	$\sin \frac{1}{2}c$	" "	f_7

the error in the sum from which $\cot \mu$ is determined will be

$$f_1 + \tfrac{1}{2}f_2 + \tfrac{1}{2}f_3 - f_5$$

whence there arises an error

in μ equal to $-\frac{r}{2m} \sin 2\mu(f_1 + \frac{1}{2}f_2 + \frac{1}{2}f_3 - f_4 - f_5)$

in log cos μ " " $\sin^2\mu(f_1 + \frac{1}{2}f_2 + \frac{1}{2}f_3 - f_4 - f_5) + f_6$

in log sin $\frac{1}{2}c$ " " $f_1 + \frac{1}{2}f_2 + \frac{1}{2}f_3 - \sin^2\mu(f_1 + \frac{1}{2}f_2 + \frac{1}{2}f_3 - f_4 - f_5) - f_6$

$= \cos^2\mu(f_1 + \frac{1}{2}f_2 + \frac{1}{2}f_3) + \sin^2\mu(f_4 + f_5) - f_6$

and in c equal to $\frac{2r}{m} \tan \frac{1}{2}c \left\{ \cos^2\mu(f_1 + \frac{1}{2}f_2 + \frac{1}{2}f_3) + \sin^2\mu(f_4 + f_5) - f_6 - f_7 \right\}$

§ 3.

Thus the error of computation takes the form

$$\alpha_1 f_1 + \alpha_2 f_2 + \alpha_3 f_3 + \ldots + \alpha_\nu f_\nu$$

in which the coefficients α are known, but in which only the limits of the quantities f_1, f_2, etc., are determined.

Assume each f to have this limiting value, and add the products

$$\alpha_1 f_1 + \alpha_2 f_2 + \alpha_3 f_3 + \ldots,$$

the signs + or — being disregarded, and the result is the greatest possible error

$$= \Sigma(\alpha f);$$

the extreme limits within which the error of the computation must necessarily be included are

$$-\Sigma(\alpha f) \text{ and } +\Sigma(\alpha f).$$

But the error will never reach these extreme limits, since each error included within the expression frequently diminishes to an infinitesimal, so that the maximum error as given above is not a suitable test by which to measure the accuracy of the computation. If for each error lying within these limits a proportional number could be determined, which would exhibit the relation that holds between the number of errors of that magnitude and the total number of errors of every magnitude, or which shows how many errors of a certain magnitude there would be among all the errors possible, we should have enough proportionals to test the accuracy of any formula.

Such numbers may be found if first we give to each f all the different values that are possible, then substitute in the sum

$$\alpha_1 f_1 + \alpha_2 f_2 + \alpha_3 f_3 + \ldots + \alpha_\nu f_\nu$$

all the combinations of the different quantities; in this way we may observe how often the sum will equal zero, and how often it will be equal to any other given number within its extreme limits.

§ 4.

If γ denotes the extreme limit of the error by which the logarithms of a given table can be affected, all the values which f can have are shown by the series

$$-\frac{n}{n}\gamma, -\frac{n-1}{n}\gamma, -\frac{n-2}{n}\gamma, \ldots\ldots \quad 0 \ldots\ldots + \frac{n-1}{n}\gamma, + \frac{n}{n}\gamma$$

in which n is an infinite number. The total number of these values is $2n + 1$. And it is a necessary assumption that each one of these values will occur once, and only once, since there is no cause at work which will give predominance to one value rather than another.

Then if we form a series of the values of $\alpha_1 f_1$, this series, which is merely the previous one multiplied by α_1, will be

$$-\frac{n}{n}\alpha_1\gamma, -\frac{n-1}{n}\alpha_1\gamma, -\frac{n-2}{n}\alpha_1\gamma \ldots\ldots \quad 0 \ldots\ldots + \frac{n-1}{n}\alpha_1\gamma, + \frac{n}{n}\alpha_1\gamma.$$

We shall have a similar series for each αf; the number of terms is the same in all, but the intervals are not the same. In place of these, and for the sake of simplicity, let the various series be so written that the terms have a common interval. It is evident that this is legitimate, since it is merely so distributing the total interval between $-\alpha_1\gamma$ and $+\alpha_1\gamma$ that the number of small intervals is changed. Thus instead of $\alpha_1 f_1$, $\alpha_2 f_2$, ... we write the series

$$\begin{array}{ll}
-\frac{n\alpha_1}{n}\gamma, -\frac{n\alpha_1-1}{n}\gamma \ldots & 0 \ldots + \frac{n\alpha_1-1}{n}\gamma, + \frac{n\alpha_1}{n}\gamma \\
-\frac{n\alpha_2}{n}\gamma, -\frac{n\alpha_2-1}{n}\gamma \ldots & 0 \ldots + \frac{n\alpha_2-1}{n}\gamma, + \frac{n\alpha_2}{n}\gamma \\
\ldots\ldots & \ldots\ldots \\
-\frac{n\alpha_\nu}{n}\gamma, -\frac{n\alpha_\nu-1}{n}\gamma \ldots & 0 \ldots + \frac{n\alpha_\nu-1}{n}\gamma, + \frac{n\alpha_\nu}{n}\gamma
\end{array}$$

in which the difference between the terms is everywhere the same, namely, $\frac{\gamma}{n}$, but the number of terms is respectively

$$2n\alpha_1+1, \quad 2n\alpha_2+1 \ldots 2n\alpha_\nu+1.$$

Furthermore, since it is required to find the number of combinations which, taken from the terms of the series, have a sum p, we form the series

$$\left.\begin{array}{l} x^{-\frac{n\alpha_1}{n}\gamma} + x^{-\frac{n\alpha_1-1}{n}\gamma} + \ldots + x^{0} + \ldots + x^{\frac{n\alpha_1-1}{n}\gamma} + x^{\frac{n\alpha_1}{n}\gamma} \\ x^{-\frac{n\alpha_2}{n}\gamma} + x^{-\frac{n\alpha_2-1}{n}\gamma} + \ldots + x^{0} + \ldots + x^{\frac{n\alpha_2-1}{n}\gamma} + x^{\frac{n\alpha_2}{n}\gamma} \\ \ldots\ldots \qquad \ldots\ldots \qquad \ldots\ldots \\ x^{-\frac{n\alpha_\nu}{n}\gamma} + x^{-\frac{n\alpha_\nu-1}{n}\gamma} + \ldots + x^{0} + \ldots + x^{\frac{n\alpha_\nu-1}{n}\gamma} + x^{\frac{n\alpha_\nu}{n}\gamma} \end{array}\right\} [3]$$

and multiply these together. The coefficient of the term x^p will be the required number.

To facilitate the multiplication, let us first divide the series by

$$x^{-\alpha_1\gamma},\ x^{-\alpha_2\gamma} \ldots\ x^{-\alpha_\nu\gamma}$$

respectively, and put

$$x^{\frac{\gamma}{n}} = z,\ \ 2n\alpha_1+1 = u_1,\ \ 2n\alpha_2+1 = u_2 \ldots\ \ 2n\alpha_\nu+1 = u_\nu.$$

Thus, (having thrown out the factors

$$x^{-\alpha_1\gamma},\ \ x^{-\alpha_2\gamma}, \text{etc.},)$$

there results the series

$$\begin{array}{l} 1 + z + z^2 + \ldots + z^{u_1-1} \\ 1 + z + z^2 + \ldots + z^{u_2-1} \\ \ldots\ldots \qquad \ldots\ldots \\ 1 + z + z^2 + \ldots + z^{u_\nu-1} \end{array}$$

in place of which can be written the expressions

$$\frac{1-z^{u_1}}{1-z},\ \ \frac{1-z^{u_2}}{1-z},\ \ \ldots\ \ \frac{1-z^{u_\nu}}{1-z}.$$

The product of these

$$\frac{(1-z^{u_1})\,(1-z^{u_2})\,\ldots\,(1-z^{u_\nu})}{(1-z)^{\nu}}$$

is to be changed into a series of powers of z. And so instead of the divisor

$$(1-z)^{\nu}$$

we assume the series of ascending powers of z,

$$1 + A_1 z + A_2 z^2 + \ldots A_t z^t + \ldots$$

of which the general term is

$$A_t z^t = \frac{\nu(\nu+1)\,(\nu+2)\,\ldots\,(\nu+t-1)}{1.2.3\quad\ldots\quad t} z^t.$$

In place of the numerator, if we multiply its factors, we have the series

$$1-(z^{u_1}+z^{u_2}+\ldots+z^{u_\nu})+(z^{u_1+u_2}+z^{u_1+u_3}+\ldots+z^{u_{\nu-1}+u_\nu})$$

$$-(z^{u_1+u_2+u_3}+z^{u_1+u_2+u_4}+\ldots+z^{u_{\nu-2}+u_{\nu-1}+u_\nu})$$

$$+\ldots\ldots+(-1)^{\nu} z^{u_1+u_2+\ldots+u_\nu}$$

and if this series be multiplied by the series for

$$(1-z)^{-\nu}$$

the coefficient of the term z^t will be

$$A_t-(A_{t-u_1}+A_{t-u_2}+\ldots+A_{t-u_\nu})+A_{t-u_1-u_2}+A_{t-u_1-u_3}$$

$$+\ldots\ldots+A_{t-u_{\nu-1}-u_\nu}-(A_{t-u_1-u_2-u_3}+\ldots.)+\ldots.$$

In this expression we are to retain only those terms which have positive indices.

The binomial coefficient

$$A_t = (\nu+t-1)_t = (\nu+t-1)_{\nu-1}$$

in this last form of the numerator arises from a finite number $(\nu-1)$ of factors, of which the first is $\nu+t-1$, the last $t+1$. Furthermore, since it must be assumed that all the exponents $t, u_1, u_2, \ldots$ finally become infinite, we may write instead of

$$(\nu+t-1)_{\nu-1}$$

the expression

$$\frac{t^{\nu-1}}{(\nu-1)!},$$

where $(\nu-1)!$ is the product $1.2.3 \ldots (\nu-1)$. This change is merely the neglect of the lower powers of t in comparison with higher. At the same time the coefficients

$$A_{t-u_1}, \quad A_{t-u_2},$$

etc., are changed in value. Thus if $s_\mu u$ denotes the sum of μ elements of the series $u_1, u_2, u_3 \ldots u_\nu$ the coefficient of the term z^t will be

$$\frac{1}{(\nu-1)!}\left\{ t^{\nu-1} - \Sigma(t-s_1u)^{\nu-1} + \Sigma(t-s_2u)^{\nu-1} - \ldots \right\} \qquad [4]$$

in which Σ signifies the sum of all the similar values, and all the sums $s_\mu u$ which are greater than t are omitted.

In order that the coefficient of the term x^p may be found, its value, expressed as a function of x, must be substituted for z, and also the multiplication by the factors neglected above,

$$x^{-\alpha_1\gamma}, \; x^{-\alpha_2\gamma}, \; \ldots x^{-\alpha_\nu\gamma},$$

must be performed, so that the power z^t is changed into

$$x^{\frac{t}{n}\gamma - (\alpha_1+\alpha_2+\ldots+\alpha_\nu)\gamma} = x^p.$$

Thus we must put

$$t = (\frac{p}{\gamma} + \alpha_1 + \alpha_2 + \ldots . \alpha_\gamma)n$$

in order that everything may be included in the quantity p. Furthermore, if we put for brevity

$$\tfrac{1}{2}(\frac{p}{\gamma} + \alpha_1 + \alpha_2 + \ldots . + \alpha_\gamma) = m$$

and instead of u_1, u_2, ... u_γ, write the corresponding values $2n\alpha_1+1$, $2n\alpha_2+1$, ... $2n\alpha_\gamma+1$ we have

$$t - u_1 = 2n(m - \alpha_1)$$
$$t - u_2 = 2n(m - \alpha_2)$$

and in general

$$t - s_\mu u = 2n(m - s_\mu \alpha)$$

in which $s_\mu \alpha$ denotes the sum of μ elements in the series

$$\alpha_1, \alpha_2, \alpha_3, \ldots . \alpha_\gamma$$

By these substitutions we have

$$\frac{(2n)^{\gamma-1}}{(\gamma-1)!}\left\{m^{\gamma-1} - \Sigma(m - s_1\alpha)^{\gamma-1} + \Sigma(m - s_2\alpha)^{\gamma-1} - \ldots .\right\}$$

as the coefficient of the power

$$x\left\{2m - (\alpha_1 + \alpha_2 + \ldots . \alpha_\gamma)\right\}^\gamma;$$

this then is the number that indicates how many times among the total number of combinations,

$$(2n)^\gamma \alpha_1 \alpha_2 \alpha_3 \ldots . \alpha_\gamma,$$

that one is found whose sum is

$$\left\{2m - (\alpha_1 + \alpha_2 + \ldots . + \alpha_\gamma)\right\}^\gamma$$

Lastly, if we divide by the total number of combinations, we have the *probability* of the error

$$\left\{2m-(\alpha_1+\alpha_2+\ldots+\alpha_\nu)\right\}\nu \text{ viz:}$$

$$\frac{1}{2n(\nu-1)!\alpha_1\alpha_2\ldots\alpha_\nu}\left\{m^{\nu-1}-\Sigma(m-\varepsilon_1\alpha)^{\nu-1}+\Sigma(m-\varepsilon_2\alpha)^{\nu-1}-\ldots\right\} \quad [5]$$

Therefore the probability of any particular error approaches zero as n is increased without limit.

§ 5.

If it is required to find the formula which expresses the number of combinations within certain limits, it is only necessary to choose a series of exponents in the product of the series [3] of § 4 and sum the coefficients. For this purpose let us return to [4] and take the coefficient of the term z^t,

$$\frac{1}{(\nu-1)!}\left\{t^{\nu-1}-\Sigma(t-\varepsilon_1 u)^{\nu-1}+\Sigma(t-\varepsilon_2 u)^{\nu-1}-\ldots\right\}$$

and for t write in order all its values from $t=1$ to $t=t$ and sum them, which will give the expression required. First $t^{\nu-1}$ is changed into the series

$$1+2^{\nu-1}+3^{\nu-1}+4^{\nu-1}+\ldots+t^{\nu-1};$$

this series is equivalent to

$$t^\nu\left\{\left(\frac{1}{t}\right)^{\nu-1}+\left(\frac{2}{t}\right)^{\nu-1}+\left(\frac{3}{t}\right)^{\nu-1}+\ldots+\left(\frac{t}{t}\right)^{\nu-1}\right\}\frac{1}{t}$$

which, if t is assumed infinite, can be expressed by the integral

$$t^\nu\int_0^1 x^{\nu-1}\,dx=\frac{t^\nu}{\nu}$$

By the same method,

$$(t-u_1)^{\nu-1}, \quad (t-u_2)^{\nu-1}, \text{ etc.,}$$

in which t does not take values less than u_1, u_2, etc., become

$$\frac{1}{\nu}(t-u_1)^{\nu}, \quad \frac{1}{\nu}(t-u_2)^{\nu}, \quad \text{etc.}$$

The sum of these can be expressed in the form

$$\frac{1}{\nu}\Sigma(t-\varepsilon_1 u)^{\nu}$$

Similarly the powers

$$(t-u_1-u_2)^{\nu-1}, \quad (t-u_1-u_3)^{\nu-1} \ldots\ (t-u_{\nu-1}-u_{\nu})^{-1}$$

in which t has as its least values

$$(u_1+u_2), \quad (u_1+u_3), \quad \ldots(u_{\nu-1}+u_{\nu}),$$

can be expressed in the form

$$\frac{1}{\nu}\Sigma(t-\varepsilon_2 u)^{\nu}$$

Thus the sum of all the coefficients of the powers from z^0 to z^t will be

$$\frac{1}{\nu!}\left\{t^{\nu}-\Sigma(t-\varepsilon_1 u)^{\nu}+\Sigma(t-\varepsilon_2 u)^{\nu}-\ldots\right\}$$

Then, substituting according to the same plan that was used in § 4 and dividing by the sum of all the coefficients or (which is the same thing) by the number of all the combinations, we have

$$\frac{1}{\nu!\alpha_1\alpha_2\alpha_3\ldots\alpha_{\nu}}\left\{m^{\nu}-\Sigma(m-\varepsilon_1\alpha)^{\nu}+\Sigma(m-\varepsilon_2\alpha)^{\nu}-\ldots\right\} \qquad [6]$$

which is the probability that the error is between the limits

$$-(\alpha_1+\alpha_2+\ldots+\alpha_{\nu})\nu \text{ and } \left\{2m-(\alpha_1+\alpha_2+\ldots+\alpha_{\nu})\right\}\nu$$

The value of this will be equal to unity if we put

$$m = \alpha_1+\alpha_2+\ldots.+\alpha_\nu$$

representing thus the certainty that the error must always be between

$$-(\alpha_1+\alpha_2+\ldots.+\alpha_\nu)\gamma \text{ and } +(\alpha_1+\alpha_2+\ldots.+\alpha_\nu)\gamma$$

If, however, we had preferred to develop the series in § 4 according to decreasing powers instead of increasing, we should have reached the same formula for determining the probability of an error situated between

$$(\alpha_1+\alpha_2+\ldots.+\alpha_\nu)\gamma \text{ and } (\alpha_1+\alpha_2+\ldots.+\alpha_\nu-2m)\gamma$$

And if we put

$$m = \tfrac{1}{2}(\alpha_1+\alpha_2+\ldots.+\alpha_\nu)$$

it must be assumed that the value of this equals ½, as indeed is the case. But if we put

$$m > (\alpha_1+\alpha_2+\ldots.+\alpha_\nu)$$

the formula will still give a value equal to unity; this and many other properties of the same formula, which can be proved by the theory of finite sums and differences, it is needless to follow out here.

Lastly, if we designate the probability [6] found above as W_m, and put

$$\alpha_1+\alpha_2+\alpha_3+\ldots.\alpha_\nu = s$$

then W_m is the probability that the error lies between $-s\gamma$ and $-(s-2m)\gamma$ and $\frac{1}{2}-W_m$ is the probability that it is between $-(s-2m)\gamma$ and 0. And so, since the probability is the same if the limits are positive, the probability that the error lies between the limits $\pm(s-2m)\gamma$ is $1-2W_m$, in which m receives in order all the values from 0 to $\frac{1}{2}s$.

§ 6.

To show by an example how the formula is to be used, let us take twenty logarithms from the tables and form their sum. All the logarithms taken from the table are affected by an error, of which the limit is one-half the last decimal place; it is required to find the error of the sum.

Here we take $\alpha_1=\alpha_2=\ldots.=\alpha_\nu=1$, $\nu=20$ and $\gamma = \frac{1}{2}$ of the last decimal place. The sums $s_1\alpha$, of which there 20, each equal 1; $s_2\alpha=2$, there being $\frac{20\,.\,19}{1\,.\,2}$ of these sums; $s_3\alpha=3$, and of these there are $\frac{20\,.\,19\,.\,18}{1\,.\,2\,.\,3}$; etc. So W_m becomes according to [6]

$$\frac{1}{20!}\left\{m^{20}-20(m-1)^{20}+\frac{20\,.\,19}{1\,.\,2}(m-2)^{20}-\frac{20\,.\,19\,.\,18}{1\,.\,2\,.\,3}(m-3)^{20}\right.$$

$$\left.+\frac{20\,.\,19\,.\,18\,.\,17}{1\,.\,2\,.\,3\,.\,4}(m-4)^{20}-\ldots.\right\}$$

The extreme limits of the error are — 10 and + 10, and the probability that the error (without regard to sign) is between 0 and $10 - m$ is $1 - 2W_m$. Then if instead of m we put in turn 1, 2, 3, . . . 9, we have the probability of an error between the limits 0 and 9, 8, 7, . . . 1. Performing the subtraction and putting the total number of different errors equal to 10,000, we have

between	0 and 1,	5,586	errors.
"	1 " 2,	3,194	"
"	2 " 3,	1,025	"
"	3 " 4,	178	"
"	4 " 5,	16	"
"	5 " 6,	1	"
"	6 " 10,	0	"

that is to say, among 10,000 sums which are made by the addition of 20 logarithms taken from the table, 5,586 are affected by an error between the limits 0 and 1 in terms of the last place of decimals, and the error of no sum is greater than 6.

This computation can be tested to some extent by several trial additions of twenty logarithms. Take as an example the sum

of the first twenty incommensurable logarithms from a table of five decimal places, in which we find, by comparison with the sum of the same seven place logarithms, an error — 1.66; in other words the sum of the five place logarithms is 1.66 less in terms of the last decimal place than the sum of the seven place logarithms of the same numbers. Let us find in the same manner the error in the sum of each succeeding twenty logarithms (the rational logarithms of the numbers 1, 10, 100, being omitted).

The errors are found to be:*

Sum of logarithms.			
2 — 22	error	— 1,66
23 — 42	"	— 2,16 †
43 — 62	"	— 0,81
63 — 82	"	— 2,02
83 — 103	"	+ 0,42
104 — 123	"	+ 0,83
124 — 143	"	— 0,07
144 — 163	"	+ 0,87
164 — 183	"	+ 0,23
184 — 203	"	+ 0,01
204 — 223	"	— 1,75 †
224 — 243	"	+ 3,23
244 — 263	"	— 0,12 †
264 — 283	"	— 1,54
284 — 303	"	+ 0,18 †
304 — 323	"	— 0,12
324 — 343	"	+ 0,19
344 — 363	"	+ 0,75
364 — 383	"	— 1 67
384 — 403	"	+ 0,80

* By performing the addition from two different sets of seven place tables (one of them Vega, Bremiker's 10th edition; Berlin 1887), I find consistently these results:

Sum of logarithms 124-143 error —1.92
224-243 +3.13

I also find several mistakes in signs which I have corrected, judging them to be misprints in the Latin edition. I did not correct the two given above, although it seems they should be as here given. If corrected, then the summary just below should read

12 errors between 0 and 1
5 " " 1 " 2
2 " " 2 " 3
1 " " 3 " 4

which agrees with the theoretical results given a few lines below better than those given by Bremiker.— E. F. C.

† I have changed the signs of these numbers.—E. F. C.

so in these twenty sums selected at random there are

13	errors	between	0	and	1
4	"	"	1	"	2
2	"	"	2	"	3
1	"	"	3	"	4

We should compare these numbers with those found above, dividing of course by 500 since in this case there are only twenty sums, instead of 10,000. After this division the probability is

11,2	errors	between	0	and	1
6,4	"	"	1	"	2
2,0	"	"	2	"	3
0,4	"	"	3	"	4

so that there is as great an agreement as could be expected in so small a number of sums.

The smallness of the probability of the larger errors is seen both from this result and from the example above, since in 10,000 errors of this kind, only one exceeds five units; the extreme limit of ten units is so far remote from the range of errors which actually occur that errors of that sort are to be regarded as practically non-existent. For by actual computation the probability of an error between 9 and 10 is found to be 1: 2432 900 000 000 000 000. Moreover the extreme limit of error is of little value in logarithmic computations, as will appear below, where more accurate criteria are proposed for testing such computation.

§ 7.

In discussions of the probability of errors the *probable error* and the *mean error* must receive especial consideration. The limits within which exactly half of the total number of errors is situated is called the probable error. Thus the probable error, according to our formula, is $(s - 2m)\gamma$ if m satisfies the equation $1-2W_m = \frac{1}{2}$ or $W_m = \frac{1}{4}$. This equation cannot be solved by any direct method.

The mean error denotes the arithmetical mean of all possible

errors, computed from the errors without regard to sign. We obtain it if we multiply the error $(s - 2m)\nu$ by its probability

$$\frac{1}{2n(\nu-1)!\alpha_1\alpha_2\ldots\alpha_\nu}\left\{m^{\nu-1} - \Sigma(m-s_1\alpha)^{\nu-1} + \Sigma(m-s_2\alpha)^{\nu-1} - \ldots\right\}$$

and double the integral of the product taken between the limits 0 and $\frac{1}{2}s$. By this integration, either direct or as in § 5, we have

$$\frac{4\nu}{(\nu+1)!\alpha_1\alpha_2\ldots\alpha_\nu}\left\{\left(\frac{s}{2}\right)^{\nu+1} - \Sigma\left(\frac{s}{2}-s_1\alpha\right)^{\nu+1} + \Sigma\left(\frac{s}{2}-s_2\alpha\right)^{\nu+1} - \ldots\right\} \quad [17]$$

In this formula we are to take only those sums of powers that have positive exponents. If we take the same example as in § 6, we have, according to this formula, the mean error equal to 1.03266. The probable error, however, is found to be slightly less than 1.

§ 8.

By the means proposed above we can determine the probability of an error within any assigned limits in any quantity computed by logarithms. Since, moreover, we have already shown how the probable error and the mean error can be found, the general problem may be considered as solved; unless there remain further difficulties in applying the formulas. For it happens that, whenever ν is a large number, the separate terms of the series employed are formed from very large numbers which in turn cancel each other, so that it is necessary to use many more decimal places in the computation than are required in the completed result. Thus in the example in § 6, eight place logarithms were used in order that the probability might be computed to four places. And for greater values of ν the difficulties are increased to such an extent that if $\nu = 100$ the computation of the values can scarcely be undertaken.

In order to avoid these difficulties, theoretical accuracy must be to some extent sacrificed and resort had to approximate values, in order that we may express results in terms of the integral of e^{-z^2}, which is of fundamental importance in discussions of probability.

§ 9.

For this purpose let us return to the series [3] of § 4 and put $e^{-z\sqrt{-1}}$ for $\frac{\gamma}{x^n}$, so that if i is written instead of $\sqrt{-1}$ they are changed into

$$e^{-n\alpha_1 zi} + e^{-(n-1)\alpha_1 zi} + \ldots + e^{0} + \ldots + e^{(n-1)\alpha_1 zi} + e^{n\alpha_1 zi} = \varphi_1(z)$$
$$e^{-n\alpha_2 zi} + e^{-(n-1)\alpha_2 zi} + \ldots + e^{0} + \ldots + e^{(n-1)\alpha_2 zi} + e^{n\alpha_2 zi} = \varphi_2(z)$$
$$\ldots\ldots \qquad \ldots\ldots \qquad \ldots\ldots$$
$$e^{-n\alpha_\nu zi} + e^{-(n-1)\alpha_\nu zi} + \ldots + e^{0} \ldots + e^{(n-1)\alpha_\nu zi} + e^{n\alpha_\nu zi} = \varphi_\nu(z)$$

By multiplying together these series we have, as before, a series whose coefficients show how many times the exponents can be combined into any given sum. We have accordingly

$$\varphi_1(z) \cdot \varphi_2(z) \ldots \varphi_\nu(z) = \Sigma k_t \, e^{tzi}$$

if k_t is the coefficient of the power e^{tzi} in which t receives all values from

$$-n(\alpha_1 + \alpha_2 + \ldots + \alpha_\nu) \text{ to } +n(\alpha_1 + \alpha_2 + \ldots \alpha_\nu)$$

If we multiply this equation by $e^{-t'zi}$ and integrate between the limits $-\pi$ and $+\pi$ we shall have on the right hand side the sum of integrals of which each one, as

$$k_t \int e^{(t-t')zi} dz$$

becomes equal to zero if t and t' have different values, excepting only the one in which $t = t'$, which will equal $2\pi k_t$ so that we have

$$\frac{1}{2\pi} \int_{-\pi}^{\pi} \varphi_1(z).\varphi_2(z) \ldots \varphi_\nu(z) e^{-tzi} dz = k_t \qquad [8]$$

Then if we give in turn to t all values from $-nc$ to $+nc$, instead of e^{-tzi} we have the series

$$e^{-nczi}+e^{-(nc-1)zi}+\ldots.+e^{0}+\ldots.+e^{(nc-1)zi}+e^{nczi}$$

$$= e^{-nczi}(1+e^{zi}+e^{2zi}+\ldots.+e^{(2nc-1)zi}+e^{2nczi})$$

$$= e^{-nczi}\frac{1-e^{(2nc+1)zi}}{1-e^{zi}}$$

$$= e^{-nczi}.\frac{e^{\frac{2nc+1}{2}zi}}{e^{\frac{z}{2}i}} \cdot \frac{\sin(\frac{2nc+1}{2}z)}{\sin\frac{1}{2}z} = \frac{\sin(\frac{2nc+1}{2}z)}{\sin\frac{1}{2}z}.$$

Similarly it is found that

$$\varphi_1(z) = \frac{\sin(\frac{2n\alpha_1+1}{2}z)}{\sin\frac{1}{2}z}, \quad \varphi_2(z) = \frac{\sin(\frac{2n\alpha_2+1}{2}z)}{\sin\frac{1}{2}z}$$

etc. By these substitutions the integral shown above is changed into

$$\Sigma k_t \text{ [from } t = -c \text{ to } t = +c]$$

$$= \frac{1}{2\pi}\int_{-\pi}^{+\pi} \frac{\sin(\frac{2n\alpha_1+1}{2}z).\ \sin(\frac{2n\alpha_2+1}{2}z)\ \ldots.\ \sin(\frac{2n\alpha_\nu+1}{2}z)\sin(\frac{2nc+1}{2}z)}{(\sin\frac{1}{2}z)^\nu} \cdot \frac{}{\sin\frac{1}{2}z}dz$$

or, if we put $nz = x$, into

$$\frac{1}{\pi}\int_{-\infty}^{+\infty} \frac{\sin\alpha_1 x.\sin\alpha_2 x\ldots.\sin\alpha_\nu x\ \sin cx}{(\sin\frac{x}{2n})^\nu} \cdot \frac{}{x}dx$$

But the function which is to be integrated here becomes a maximum if x is taken equal to zero. As x increases, the numerator repeatedly becomes zero, while the denominator continually increases, so that we have a sufficiently exact value for the integral if we take large finite quantities $-g$ and $+g$ in place of the infinite limits. By this substitution $\sin\frac{x}{2n}$ is changed into $\frac{x}{2n}$ for the quantity n is assumed infinite. Thus after division by

$$(2n)^{\nu}\,\alpha_1\alpha_2\ldots\ldots\alpha_\nu$$

we have the probability V_c of an error between the limits $-c$ and $+c$.

$$V_c = \frac{1}{\pi}\int_{-g}^{+g} \frac{\sin\alpha_1 x}{\alpha_1 x}\cdot\frac{\sin\alpha_2 x}{\alpha_2 x}\ldots\ldots\frac{\sin\alpha_\nu x}{\alpha_\nu x}\cdot\frac{\sin cx}{x}\,dx$$

Then if each sine is expressed as a series, so that

$$\log\left(\frac{\sin\alpha_1 x}{\alpha_1 x}\right) = -\tfrac{1}{6}\alpha_1{}^2x^2 - \tfrac{1}{180}\alpha_1{}^4x^4 - \ldots\ldots$$

and similarly for

$$\log\left(\frac{\sin\alpha_2 x}{\alpha_2 x}\right)\ldots\ldots\log\left(\frac{\sin\alpha_\nu x}{\alpha_\nu x}\right)$$

we have

$$\log\left(\frac{\sin\alpha_1 x}{\alpha_1 x}\cdot\frac{\sin\alpha_2 x}{\alpha_2 x}\ldots\ldots\frac{\sin\alpha_\nu x}{\alpha_\nu x}\right) = -\tfrac{1}{6}\nu\sigma^2x^2 - \tfrac{1}{180}\nu\sigma'^4x^4 - \ldots\ldots$$

if we put

$$\alpha_1{}^2+\alpha_2{}^2+\ldots\ldots+\alpha_\nu{}^2=\nu\sigma^2 \qquad [9]$$

and

$$\alpha_1{}^4+\alpha_2{}^4+\ldots\ldots+\alpha_\nu{}^4=\nu\sigma'^4 \qquad [10]$$

But this series can only be substituted if it is convergent, which is the case if a function of the variable ν of the form $k\nu^{-\lambda}$ is substituted for x. By this operation the series is changed to

$$-\frac{k^2\sigma^2}{6}\nu^{1-2\lambda} - \frac{k^4\sigma'^4}{180}\nu^{1-4\lambda} - \ldots.$$

in which the first term increases, and all the others diminish, for increasing values of ν provided λ is assumed to satisfy

$$\tfrac{1}{2} > \lambda > \tfrac{1}{4}$$

For then the exponent of ν will be positive in the first term, and negative in all the others. For example, let $\lambda = \frac{1}{3}$ and we obtain the series

$$-\tfrac{1}{6}k^2\sigma^2\nu^{\frac{1}{3}} - \tfrac{1}{180}k^4\sigma'^4\nu^{-\frac{1}{3}} - \ldots.$$

Hence if in the integral written above, we take the limits $g = k\nu^{-\frac{1}{3}}$ instead of the limits $-\infty$ and $+\infty$, we shall approach the more nearly to the true value of the integral the greater the value of ν. For we have

$$V_c = \frac{1}{\pi}\int_{-g}^{+g} e^{-\frac{1}{6}\nu\sigma^2x^2}\left(1-\tfrac{1}{180}\nu\sigma'^4x^4\right)\frac{\sin cx}{x}dx$$

and if we put $z = x\sqrt{\frac{\nu}{6}}$

$$V_c = \frac{1}{\pi}\int e^{-\sigma^2z^2}\left(1-\frac{1}{5\nu}\sigma'^4z^4\right)\frac{\sin cz\sqrt{\frac{6}{\nu}}}{z}dz$$

The limits will be

$$\pm k\nu^{-\frac{1}{2}} \cdot \sqrt{\frac{\nu}{6}} = \frac{k}{\sqrt{6}}\nu^{\frac{1}{2}}$$

in place of which ∞ may again be substituted since this limit becomes infinite with ν. Moreover the function to be integrated remains the same whether x has its positive or negative value, hence 0 may be put as the inferior limit and the integral doubled. Thus we have

$$V_c = \frac{2}{\pi}\int_0^{\infty} e^{-\sigma^2 z^2}\left(1 - \frac{1}{5\nu}\sigma^4 z^4\right)\frac{\sin cz\sqrt{\frac{6}{\nu}}}{z}dz \qquad [11]$$

which can be considered as the sum of two integrals and computed by the assistance of the ordinary formula

$$\int_0^{\infty} e^{-\alpha^2 x^2}\cos 2\beta x\, dx = \frac{\sqrt{\pi}}{2\alpha}e^{\frac{-\beta^2}{\alpha^2}}$$

For by integration between 0 and l with respect to β this gives

$$\int_0^{\infty} e^{-\alpha^2 x^2}\frac{\sin 2lx}{x}dx = \frac{\sqrt{\pi}}{\alpha}\int_0^{l} e^{-\frac{\beta^2}{\alpha^2}}d\beta,$$

which is the desired reduction for the first part of the integral. Whence

$$V'_c = \frac{2}{\sigma\sqrt{\pi}}\int_0^{\frac{c}{2}\sqrt{\frac{6}{\nu}}} e^{-z^2}dz = \frac{2}{\sqrt{\pi}}\int_0^{\frac{c}{2\sigma}\sqrt{\frac{6}{\nu}}} e^{-z^2}dz. \qquad [12]$$

If, however, we differentiate the formula three times with respect to β we have

$$\int_0^\infty e^{-\alpha^2x^2}x^3 \sin 2\beta x dx = \frac{\sqrt{\pi}}{2\alpha} e^{\frac{-\beta^2}{\alpha^2}} \left(\frac{3\beta}{2\alpha^4} - \frac{\beta^3}{\alpha^6}\right)$$

which we can employ in the reduction of the other part of the integral; thus

$$V''_c = \frac{3c\sigma'^4\sqrt{\frac{6}{\pi}}}{20\nu^{\frac{7}{2}}\sigma^5} - e^{-\frac{3c^2}{2\nu\sigma^2}}\left(1-\frac{c^2}{\nu\sigma^2}\right) \qquad [13]$$

Finally the equation

$$V = V' - V'' \qquad [14]$$

shows the probability of an error lying between $-cz$ and $+cz$; the second part V'' either vanishes for large values of ν or is very small.

§ 10.

If $h\gamma$ denotes the probable error, according to the definition V_h will equal ½. In order to find h from this, first take $V'' = 0$ and compute h by means of the equation $V'_h = ½$. Thus by the aid of a table which shows the value of the integral

$$\frac{2}{\sqrt{\pi}} \int_0^z e^{-z^2}dz$$

corresponding to any value of z it is found that $z = 0.476936$ if the integral itself equals ½. This value of z being denoted by ρ, we have from the equation $V'_c = ½$

$$\frac{c}{2\sigma}\sqrt{\frac{6}{\nu}} = \rho \quad \text{or} \quad c = 2\sigma\rho\sqrt{\frac{\nu}{6}}$$

Thus we compute c as a first approximation to h; then on putting $c+dc = h$ we shall have dc from the equation

$$dV'cdc = V'c \quad \text{or} \quad dc = \frac{V''}{dV'} *$$

in which the value just found is to be substituted in place of c. Thus, since

$$dVc = \frac{\sqrt{\frac{6}{\nu}}}{\sigma\sqrt{\pi}} e^{-\frac{3c^2}{2\nu\sigma^2}},$$

we shall have

$$dc = \frac{V''}{dV} = \frac{3\rho\sigma'^4}{10\sqrt{6\nu}.\sigma^2}(1-\tfrac{2}{3}\rho^2).$$

and

$$h = 2\sigma\rho\sqrt{\frac{\nu}{6}} + \frac{3\rho\sigma'^4}{10\sqrt{6\nu}.\sigma_2}\left(1-\tfrac{2}{3}\rho^2\right) \qquad [15]$$

Then h_ν is the probable error; but the second term either vanishes for very large values of ν or is negligible.

The mean error, defined in § 7, can in general be computed in the same way as the probable error was computed in § 9. For we may start from the equation [8] which expresses the probability of the error $\frac{t}{n}\nu$,

$$k_t = \frac{1}{2\pi}\int_{-\pi}^{+\pi} \varphi_1(z).\varphi_2(z)\ldots\varphi_\nu(z)e^{-tsi}dz.\frac{1}{(2n)^\nu\,\alpha_1\alpha_2\ldots\alpha_\nu}$$

and substitute for $\varphi_1(z)$ ..... the expressions involving sines, and substitute for the product of sines the function of the exponents. Then we shall have

$$\frac{1}{\pi}\int_0^\infty e^{-\frac{1}{2}\nu\sigma^2x^2}\left(1-\frac{\nu}{180}\sigma'^4x^4\right)e^{-exi}\frac{dx}{n}$$

* In the notation of the author, dV' here denotes the derivative of V' with respect to c. [E. F. C.]

as the probability of an error cr. Then by putting $x\sqrt{\frac{\nu}{6}} = s$ and cos cx instead of e^{-cxi} (since the imaginary part is cancelled) we shall have

$$\frac{\sqrt{\frac{6}{\nu}}}{\pi}\int_0^\infty e^{-\sigma^2 z^2}\left(1-\frac{1}{5\nu}\sigma'^4 z^4\right)\cos\left(c\sqrt{\frac{6}{\nu}}z\right)\cdot\frac{dz}{n}.$$

Finally if we employ the reduction formulas

$$\int_0^\infty e^{-\alpha^2 z^2}\cos\beta z dz = \frac{\sqrt{\pi}}{2\alpha}e^{-\frac{\beta^2}{4\alpha^2}}$$

and its fourth derivative

$$\int_0^\infty e^{-\alpha^2 z^2}\cos\beta z.z^4 dz = \frac{\sqrt{\pi}}{2\alpha}e^{-\frac{\beta^2}{4\alpha^2}}\left(\frac{3}{4\alpha^4}-\frac{3\beta^2}{4\alpha^6}+\frac{\beta^4}{16\alpha^8}\right)$$

we shall have

$$\frac{1}{n}\frac{\sqrt{\frac{6}{\nu\pi}}}{2\sigma}e^{-\frac{3c^2}{2\nu\sigma^2}}\left\{1-\frac{\sigma'^4}{5\nu}\left(\frac{3}{4\sigma^4}-\frac{9c^2}{2\nu\sigma^6}+\frac{9c^4}{4\nu^2\sigma^8}\right)\right\}$$

as the probability of an error cr.

The integral of this being taken between the limits $-c$ and $+c$, in which $\frac{1}{n}$ takes the place of dc, it is again necessary to avoid the avoid the formula for V as found in § 9. This is shown by the computation. The partial integration can be performed according to the formula

$$\int e^{-bz^2}z^{2n+2}dz = \frac{2n+1}{2b}\int e^{-bz^2}z^{2n}dz - \frac{1}{2b}e^{-bz^2}z^{2n+1}$$

and, if the factor 2 be inserted, the integrals may have zero as lower limit.

But if we multiply by $2c\gamma$ and integrate with respect to c between the limits 0 and s we shall have the mean error, or the aggregate of all the errors regardless of sign divided by the total number of them.

By partial integration according to the formula

$$\int e^{-bx^2} x^{2n+1}\,dx = \frac{n}{b}\int e^{-bx^2} x^{2n-1}dx - \frac{1}{2b}e^{-bx^2}x^{2n}$$

all parts of the integral can be reduced to the form

$$\int_0^s e^{-bx^2}x\,dx = \frac{1}{2b}(1-e^{-bs^2})$$

from which we obtain

$$2\gamma\sigma\sqrt{\frac{\gamma}{6\pi}}\left(1+\frac{\sigma'^4}{20\gamma\sigma^4}\right) \qquad [16]$$

if the terms are omitted which have $e^{-\frac{3s^2}{2\gamma\sigma^2}}$ as a factor. And this is the mean error.

§ 11.

In formula [6] of § 5 the probability of an error between the limits $\pm(s-2m)\gamma$ was found to equal $1-2W$, and in § 9 this is shown to equal V_c for limits $\pm c\gamma$. So if c be taken equal to $s-2m$, $1-2W$ and V must necessarily express the same probability. But V is only an approximation, since, in deriving it, γ was assumed very large. In order that this agreement may be subjected to some numerical test, let us employ the

example of § 6. In this all values of a are put equal to 1; $\nu=20$; $\gamma=\frac{1}{2}$; so that

$$s = \alpha_1^2+\alpha_2^2+\ldots.+\alpha^2_\nu \quad = 20$$

$$\sigma^2 = \frac{1}{\nu}(\alpha_1^2+\alpha_2^2+\ldots.+\alpha_\nu^2) = 1$$

$$\sigma'^4 = \frac{1}{\nu}(\alpha_1^4+\alpha_2^4+\ldots.+\alpha_\nu^4) = 1$$

$$V' = \frac{2}{\sqrt{\pi}}\int_0^{\frac{c}{2}\sqrt{\frac{3}{10}}} e^{-z^2}dz$$

$$V' = \frac{3}{400}c\cdot\sqrt{\frac{3}{10\pi}}e^{-\frac{3}{40}c^2}\left(1-\frac{c^2}{20}\right)$$

$$= 0{,}0023177\, c\, e^{-\frac{3}{40}c^2}\left(1-\frac{c^2}{20}\right)$$

$$m = 10-\tfrac{1}{2}c$$

Furthermore if instead of c are put the values 0, 2, 4, . . . up to the limit 20, the corresponding values of

$$c\gamma,\ m,\ \frac{c}{2}\sqrt{\frac{3}{10}},\ \frac{3}{40}c^2,\ 1-\frac{c^2}{20}$$

will be as follows:*

$c\gamma$	c	m	$\frac{c}{2}\sqrt{\frac{3}{10}}$	$\frac{3}{40}c^2$	$1-\frac{c^2}{20}$
0	0	10	0	0,	+ 1,0
1	2	9	0,547725	0,3	+ 0,8
2	4	8	1,095450	1,2	+ 0,2
3	6	7	1,643175	2,7	— 0 8
4	8	6	2,190900	4,8	— 2,2
5	10	5	2,738625	7,5	— 4,0
6	12	4	3,286350	10,8	— 6,2
7	14	3	3,834075	14,7	— 8,8
3	16	2	4,381800	19,2	— 11,8
9	18	1	4,929525	24,3	— 15,2
10	20	0	5,477250	30,0	— 19,0

* I get for the first number after 0 in the fourth column 0.547723 and so on to the last 5.477226, but it hardly seems worth while to correct such small errors.—E. F. C.

Then according to the formulas [11], [12] and [13] the approximate values V', V'', V are easily derived which are compared in the following table with the corresponding values $1 - 2W$ computed according to the rigorous formulas [6] of § 5. These are indeed the same as those which were shown in § 6 giving the number of differences between 0 and 1, and 1 and 2, etc., for $c\gamma$ with regard to integers only.

$c\gamma$	V'	V''	$V = V' - V''$	$1 - 2W$
0	0	0	0	0
1	5611 2	+ 27,5	5586,7	5586,0
2	8786	+ 5 6	8781,0	8780,8
3	9798 6	— 7,5	9806 1	9806,3
4	9980,5	— 3,4	9983,9	9983,9

It is needless to continue this farther; for the values which $1 - 2W$ and V receive evidently agree closely and this happens because the quantity ν which we have assumed equal to 20 is sufficiently large. For values $\nu = 2$ or $\nu = 3$ they would agree less exactly.

According to formula [15] of § 10, the probable error is

$$h\gamma = 2\gamma\sigma\rho\sqrt{\frac{\nu}{6}} + \frac{3\gamma\rho\sigma'^4}{10\sqrt{6\nu\sigma^8}}(1 - \tfrac{2}{3}\rho^2)$$

or, if we substitute for γ, σ, σ', and ν the same values that they had above, and 0.476936 for ρ

$$h\gamma = 0{,}87076 + 0{,}00554 = 0.87630.$$

The corresponding value of m is

$$m = \frac{20-h}{2} = 9{,}12370$$

If this value of m is substituted in Wm its value (according to § 7) ought to be $\frac{1}{4}$. By making the substitution we actually obtain $Wm = 0.25002$, which may be considered perfect agreement.

The approximate value of the mean error, which we have found to equal 1.03266 by the exact formula [7] of § 7, will be

$$2\gamma\sigma\sqrt{\frac{\nu}{6\pi}}\left(1+\frac{\sigma'^4}{20\nu\sigma^4}\right)$$

from the formula of § 10 or, if the values found above are substituted,

$$=\sqrt{\frac{10}{3\pi}}\left(1+\tfrac{1}{450}\right)=1.03263,$$

A more exact agreement could not be asked.

Furthermore it is seen that if $\nu=20$ the terms which depend on σ' or on the fourth power of α are negligible in comparison with the first term. But since, as will appear below, the quantity ν is usually still larger or in a minor computation is not far different from that value, all the terms depending on σ' can be neglected altogether without fear that the result will vary far from the truth. So we can assume

$$\frac{2}{\sqrt{\pi}}\int_0^{\frac{c}{2\sigma}\sqrt{\frac{6}{\nu}}} e^{-z^2}dz \qquad [17]$$

as the probability of an error between the limits $\pm c\gamma$,

$2\gamma\sigma\rho\sqrt{\frac{\nu}{6}}$ will be the probable error, [18]

and $2\gamma\sigma\sqrt{\frac{\nu}{6\pi}}$ the mean error. [19]

Furthermore, if $\gamma=\frac{1}{2}$ expressed in terms of the last decimal place, and we put $\zeta=c\gamma$, then

$$\frac{2}{\sqrt{\pi}}\int_0^{\frac{\zeta}{\sigma}\sqrt{\frac{6}{\nu}}} e^{-z^2}dz$$

will be the probability of an error within the limits $\pm \zeta$

$\sigma\rho\sqrt{\frac{\nu}{6}}$ will be the probable error,

and $\sigma\sqrt{\frac{\nu}{6\pi}}$ the mean error,

expressed in terms of the last decimal place. Or, if there be written in place of $\nu\sigma^2$ its value $\alpha_1^2+\alpha_2^2+\ldots+\alpha_\nu=\Sigma\alpha^2$

$\rho\sqrt{\frac{\Sigma\alpha^2}{6}}$ will be the probable error,

and $\sqrt{\frac{\Sigma\alpha^2}{6\pi}}$ the mean error.

§ 12.

Before we use these formulas, let us examine more carefully the general nature of logarithmic computations. First, it must not be assumed that every time we pass over from logarithm to number or from number to logarithm an error arises whose limit is the half of unity, since we may have added to the tabular logarithm a proportional part. Also, the probability of error in different intervals is not the same, since many sources of error exist. Lastly, the limits and the probabilities of error vary according as the transition is made from number to logarithm or from logarithm to number. Hence it will be necessary to modify equations [1] and [2] of § 2, in which it was assumed that there was only a single source of error arising with each single transition. Therefore in order that everything may be correctly expressed by the formulas, let us more carefully consider the transition from number to logarithm.

If it is required to find the logarithm corresponding to a certain number, it is commonly done by adding to the tabular logarithm a proportional part from the table of differences. So

if L_1 and L_2 are the tabular logarithms between which the interpolation is to take place and ε is the fraction by which the difference $\Delta = L_2 - L_1$, is to be multiplied, according to the ordinary rule (the basis of which is to be considered here)

$$L_1 + \varepsilon\Delta$$

will be the required logarithm. In this of course $\varepsilon\,\Delta$ is accurately computed, but is expressed only in integral units of the last decimal place.

If it is assumed that f_1 and f_2 are the errors of the tabular logarithms L_1 and L_2, it is then known that since $L_1 + f_1$ and $L_2 + f_2$ are the exact values of the logarithms, the error of the logarithm $L_1 + \varepsilon\,\Delta$ will be

$$f_1 + \varepsilon(f_2 - f_1) + f_3$$

if f_3 denotes the error which arises from the curtailment of the product $\varepsilon\,\Delta$, but f is considered to be any one of the equally probable values which lie between $+\gamma$ and $-\gamma$. In each particular case the quantity ε (which lies between 0 and 1) will be fixed and definite; nor would it be difficult to introduce into the computation, if expressed numerically, all the values which ε receives during the computation. But since we desire to investigate the general case, we shall attempt to find a mean value for ε; or else we may treat all the values of ε as remaining indefinite, and finally find a probability which will show within what limits the mean error and the probable error lie.

We shall omit the consideration of the last method although it would add to the completeness and elegance of this investigation; but the final result which we seek would be helped but little.

So let us first inquire what values the sum

$$(1-\varepsilon)f_1 + \varepsilon f_2 + f_3$$

can receive if instead of each f we write all the equally probable values between $-\frac{1}{2}$ and $+\frac{1}{2}$. The formula [6] of § 5 serves best for this purpose. For if we substitute in it $\alpha_1 = 1-\varepsilon$, $\alpha_2 = \varepsilon$, $\alpha_3 = 1$, $\nu = 3$, $\gamma = \frac{1}{2}$ we shall have $s = 2$, $(s-2m)\gamma = 1-m$.

Since m can receive all values from 0 to s, the extreme limits are -1 and $+1$. By substituting these values in W_m we shall have

$$\frac{1}{6\varepsilon(1-\varepsilon)}\left\{\begin{array}{l} m^3-(m-1+\varepsilon)^3+(m-1)^3-\ldots. \\ \quad -(m-\varepsilon)^3+(m-2+\varepsilon)^3 \\ \quad -(m-1)^3+(m-1-\varepsilon)^3 \end{array}\right\}$$

But in this formula several terms in which the quantities are negative are to be omitted since m assumes only those values which lie between 0 and 1; and thus it is changed into

$$W_m=\frac{1}{6\varepsilon(1-\varepsilon)}\left\{m^3-(m-1+\varepsilon)^3-(m-\varepsilon)^3\right\}$$

in which m and ε receive all values between 0 and 1, and all powers of negative quantities are necessarily excluded. So $1-2\,W_m$ will be the probability that the sum $(1-\varepsilon)f_1+\varepsilon f_2+f_3$ lies between the limits $\pm(1-m)$. Below are the values which $1-2\,W_m$ takes for each decimal division of the values of m and ε indicated in the table:

m	$(2-2m)\gamma$	$\varepsilon=0{,}1$	$\varepsilon=0{,}2$	$\varepsilon=0{,}3$	$\varepsilon=0{,}4$	$\varepsilon=0{,}5$
0,9	0,1	0,196	0,198	0,198	0,198	0,198
0,8	0,2	0,374	0,384	0,388	0,388	0,390
0,7	0,3	0,530	0,546	0,557	0,562	0,564
0,6	0,4	0,662	0,684	0,700	0,712	0,714
0,5	0,5	0,774	0,796	0,814	0,828	0,834
0,4	0,6	0,864	0,884	0,900	0,912	0,914
0,3	0,7	0,930	0,946	0,958	0,968	0,964
0,2	0,8	0,974	0,982	0,986	0,988	0,990
0,1	0,9	0,996	0,998	0,998	0,998	0,998

There is no need to extend the table further, since for $\varepsilon=0.6$, 0.7, etc., $1-2\,W_m$ takes on the same values that it has for $\varepsilon=0.4$, $\varepsilon=0.3$, etc. If we let $\varepsilon=0$ or 1 we shall have $W_m=\frac{1}{2}\,m^3$ and so if

$(2-2m)\gamma=0{,}1$	then $1-2\,W_m=$	0,190
0,2	"	0,360
0,3	"	0,510
0,4	"	0,640
0,5	"	0,750
0,6	"	0,840
0,7	"	0,910
0,8	"	0,960
0,9	"	0,990

and the probable error and the mean error are found to be

for $\varepsilon =$	0,0	0,1	0,2	0,3	0,4	0,5
probable error =	0,293	0,279	0,270	0,263	0,262	0,261
mean error =	0,333	0,318	0,307	0,298	0,293	0,292

Hence it appears that it matters little what value ε has, since the values which the mean error and the probable error receive for various values of ε differ among themselves but little. In order to adopt a single average value and thus arrive at a more convenient form for computation, let us put $\varepsilon = \frac{1}{2}$, for which the probable error will be 0.270 and the mean error 0.307.

Therefore we may put the error of a logarithm found by interpolation as

$$f = \tfrac{1}{2}f_1 + \tfrac{1}{2}f_2 + f_3 \qquad [20]$$

If the transition is from logarithm to number or arc, the error which is to be assumed as occurring in the logarithm has the form

$$-(1-\varepsilon)f_1 - \varepsilon f_2.$$

For there are given, the logarithm $L = \log \varphi(a)$, the tabular logarithms L_1 and L_2 between which the interpolation is to be performed, the difference $L_2 - L_1 = \Delta$ and $L - L_1 = \delta$. In order that the argument a corresponding to the logarithm L may be found, the fraction $\frac{\delta}{\Delta}$ is computed and added to the argument of the logarithm L_1. Thus if $L_1 + f_1$, $L_2 + f_2$, are the true values of the logarithms, and therefore

$$\delta - f_1 \text{ and } \Delta + f_2 - f_1$$

are the true differences, we have

$$\frac{\delta - f_1}{\Delta + f_2 - f_1} = \frac{\delta}{\Delta} - \frac{1}{\Delta}f_1 - \frac{\delta}{\Delta^2}(f_2 - f_1) + \ldots,$$

Then, $\frac{\delta}{\Delta}$ being put equal to ε, the error by which a is affected will be

$$-\frac{1}{\Delta}\left\{(1-\varepsilon)f_1+\varepsilon f_2\right\}$$

But since

$$d(\log\varphi(a))=\frac{d\varphi(a)}{\varphi(a)}m\,da=\Delta da^*$$

the error of the logarithm from which a is found by means of the table may be written

$$-(1-\varepsilon)f_1-\varepsilon f_2.$$

Again, by examination of the various values of ε it appears that the value $\varepsilon=\frac{1}{2}$ holds almost the mean place. Therefore in the change from any particular logarithm to the number or to the arc the error of the logarithm may be assumed as

$$f'=-\tfrac{1}{2}f_1-\tfrac{1}{2}f_2 \qquad [21]$$

Lastly, if it is necessary to pass from the logarithm of one trigonometric function $\varphi(a)$ to the logarithm of another trigonometric function $\varphi'(a)$ by the aid of the tables, the error attaching to $\log\varphi'(a)$ is

$$f[\log\varphi'(a)]=\frac{d\log\varphi'(a)}{d\log\varphi(a)}f''+f'.$$

and it does not matter whether a is first found from $\log\varphi(a)$ and then from this $\log\varphi'(a)$, or whether the transition is made directly from $\log\varphi(a)$ to $\log\varphi'(a)$ without reference to the argument a.

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*According to the notation of the author, $d\varphi(a)$ here denotes the derivative of $\varphi(a)$ with respect to a.—[E. F. C.]

Accordingly the formulas [1] and [2] of § 2 are slightly modified, thus:

$$f(\log a) = \frac{m}{a} f(a) + f'$$

$$f(\log \sin A) = \frac{m}{r} \cot A \,.\, f(A) + f'$$

$$f(\log \cos A) = -\frac{m}{r} \tan A \,.\, f(A) + f'$$

$$f(\log \tan A) = \frac{m}{r} \frac{1}{\sin A \,.\, \cos A} \cdot f(A) + f'$$

$$f(\log \cot A) = -\frac{m}{r} \frac{1}{\sin A \,.\, \cos A} \cdot f(A) + f'$$

$$f(a) = \frac{a}{m} \left\{ f(\log a) + f' \right\}$$

$$f(A) = \frac{r}{m} \tan A \left\{ f(\log \sin A) + f' \right\}$$

$$= -\frac{r}{m} \cot A \left\{ f(\log \cos A) + f' \right\}$$

$$= \frac{r}{m} \sin A \cos A \left\{ f(\log \tan A) + f' \right\}$$

$$= -\frac{r}{m} \sin A \cos A \left\{ f(\log \cot A) + f' \right\}$$

Furthermore in the transition from log tan A and log cot A to log sin A and log cos A the following formulas are used:

$$f(\log \sin A) = \cos^2 A \,.\, f(\log \tan A) + \cos^2 A \,.\, f'' + f'$$
$$f(\log \cos A) = -\sin^2 A \,.\, f(\log \tan A) - \sin^2 A \,.\, f'' + f'$$
$$f(\log \sin A) = -\cos^2 A \,.\, f(\log \cot A) - \cos^2 A \,.\, f'' + f'$$
$$f(\log \cos A) = \sin^2 A \,.\, f(\log \cot A) + \sin^2 A \,.\, f'' + f'$$
$$f(\log \sin A) = -\cot^2 A \,.\, f(\log \cos A) - \cot^2 A \,.\, f'' + f'$$

where f' and f'' are to be taken according to formulas [20] and [21]

$$f' = \tfrac{1}{2} f_1 + \tfrac{1}{2} f_2 + f_3$$
$$f'' = -\tfrac{1}{2} f_4 - f_5$$

in which all the quantities f_1, f_2 etc., are entirely independent, so that each one denotes any one of the equally probable values between $-\frac{1}{2}$ and $+\frac{1}{2}$, whose number is infinite.

§ 13.

The formulas set forth above are sufficient to indicate the probable error and the mean error of the result of any computation according to any formula whatever, and to show how great is the likelihood that the error is contained within any assigned limits. In order to show this by an example, we shall examine more carefully some formulas according to which the third side in a spherical triangle may be found if two sides and the included angle are given.

A. First let us consider the formulas by means of which the third angle is computed by means the auxiliary angle μ where we put

$$\cot \mu = \frac{\sin \frac{1}{2} C \sqrt{\sin a \sin b}}{\sin \frac{1}{2}(a-b)}$$

and find

$$\sin \tfrac{1}{2} c = \frac{\sin \frac{1}{2} C \sqrt{\sin a \sin b}}{\cos \mu} = \frac{\sin \frac{1}{2}(a-b)}{\sin \mu}$$

From this formula log cot μ is computed by the addition of three logarithms, from the sum of which one is subtracted. Each one of these is assumed to be affected by an error f' (which in log sin a and in log sin b is in fact diminished a half on account of the division by 2, if account is taken of the half-units arising in the division of the last decimal place). So we have the equation

$$f(\log \cot \mu) = f'_1 + \tfrac{1}{2} f'_2 + \tfrac{1}{2} f'_3 - f'_4$$

in which the subscripts indicate that the various quantities f' are independent.

Then according to the equations set forth in § 12 we shall have

$$f(\log \cos \mu) = \sin^2 \mu (f'_1 + \tfrac{1}{2} f'_2 + \tfrac{1}{2} f'_3 - f'_4) + \sin^2 \mu f''_1 + f'_5$$

$$f(\log \sin u) = -\cos^2 \mu (f'_1 + \tfrac{1}{2} f'_2 + \tfrac{1}{2} f'_3 - f'_4) - \cos^2 \mu f''_2 + f'_6$$

$$f(\log \sin \tfrac{1}{2} c) = f(\log \sin \tfrac{1}{2} C \sqrt{\sin a \sin b}) - f(\log \cos \mu)$$

$$= f'_1 + \tfrac{1}{2} f'_2 + \tfrac{1}{2} f'_3 - \sin^2 \mu (f'_1 + \tfrac{1}{2} f'_2 + \tfrac{1}{2} f'_3 - f'_4)$$

$$- \sin^2 \mu f''_1 - f'_5$$

Then we have

$$f(c) = \frac{2r}{m} \tan \tfrac{1}{2} c \left\{ f(\log \sin \tfrac{1}{2} c) + f''_3 \right\}$$

If next the value found for f (log sin ½ c) is substituted in these equations and if every f' is changed into the form $\frac{2}{3} f_1 + \frac{1}{3} f_2 + f_3$, and every f'' into the form $-\frac{2}{3} f_1 - \frac{1}{3} f_2$, and then if, for simplicity, f_1, f_2, etc., be denoted by (1), (2), etc., so that we may write

$$\begin{aligned}
f'_1 &= \tfrac{2}{3}(1) + \tfrac{1}{3}(2) + (3) \\
f'_2 &= \tfrac{2}{3}(4) + \tfrac{1}{3}(5) + (6) \\
f'_3 &= \tfrac{2}{3}(7) + \tfrac{1}{3}(8) + (9) \\
f'_4 &= \tfrac{2}{3}(10) + \tfrac{1}{3}(11) + (12) \\
f''_1 &= -\tfrac{2}{3}(13) - \tfrac{1}{3}(14) \\
f'_5 &= \tfrac{2}{3}(15) + \tfrac{1}{3}(16) + (17) \\
f''_2 &= -\tfrac{2}{3}(18) - \tfrac{1}{3}(19) \\
f'_6 &= \tfrac{2}{3}(20) + \tfrac{1}{3}(21) + (22) \\
f''_3 &= -\tfrac{2}{3}(23) - \tfrac{1}{3}(24)
\end{aligned}$$

we shall have

$$f(c) = \frac{2r}{m} \tan \tfrac{1}{2} c \times \left\{ \begin{array}{l} \cos^2 \mu \left\{ \begin{array}{l} \frac{2}{3}(1) + \frac{1}{3}(2) + (3) \\ + \frac{4}{10}(4) + \frac{1}{10}(5) + \frac{1}{2}(6) \\ + \frac{1}{10}(7) + \frac{1}{10}(8) + \frac{1}{2}(9) \end{array} \right. \\ + \sin^2 \mu \left\{ \begin{array}{l} \frac{2}{3}(10) + \frac{1}{3}(11) + (12) \\ + \frac{2}{3}(13) + \frac{1}{3}(14) \end{array} \right. \\ \quad - \frac{1}{2}(15) - \frac{1}{2}(16) - (17) \\ \quad - \frac{2}{3}(23) - \frac{1}{3}(24) \end{array} \right\}$$

Therefore the probable error by which c is affected, if six place logarithms are used, is

$$wF = 10^{-6} \frac{\rho}{\sqrt{6}} \sqrt{\Sigma(u^2)}$$

in which it is necessary to write the coefficients of the quantities

(1), (2), etc., in place of α. By this substitution we shall have

$$\sqrt{\Sigma(\alpha^2)} = \frac{2r}{m} \tan \tfrac{1}{2}c \sqrt{2{,}52 \cos^4\mu + 2{,}36 \sin^4\mu + 2{,}36}$$

and, after writing for r, m, and ρ the values

$$r = 206265$$
$$m = 0{,}13120$$
$$\frac{\rho}{r\sqrt{3}} = 0{,}1917$$

we have

$$wF(c) = 0{,}13195 \tan \tfrac{1}{2}c \sqrt{2{,}52 \cos^4\mu + 2{,}36 \sin^4\mu + 2{,}36}$$

expressed in seconds.

When μ comes out $>45°$, another form is more convenient.*

$$\sin \tfrac{1}{2}c = \frac{\sin \tfrac{1}{2}(a-b)}{\sin \mu}$$

so that we have this condition:

$$wF(c) = 0{,}18495 \tan \tfrac{1}{2}c \sqrt{3{,}20 \cos^4\mu + 1{,}68 \sin^4\mu + 2{,}36}$$

From these formulas, the first for values of $\mu < 45°$, the last for $\mu > 45°$, these values of wF arise:

μ	$wF(c)$	
0°	0,40357	tan ½c
10	0,40235	"
20	0,38607	"
30	0,33641	"
40	0,35241	"
50	0,34526	"
60	0,34626	"
70	0,35628	"
80	0,36727	"
90	0,37175	"

* Those who are accustomed to computation use the following rule for computing $C^2 = A^2 + B^2$ by the aid of the auxiliary angle μ. First, $\log A - \log B$ is taken, if

Since the coefficients of tan ½ c, which depend on the quantity μ, do not vary greatly, the quantity 0.37*, which is scarcely 10% different from the extreme values, may be written as a mean value, so that we have:

c	$wF(c)$
0°	0,'00
10	0, 03
20	0, 07
30	0, 10
40	0, 14
50	0, 17
60	0, 21
70	0, 26
80	0, 31
90	0, 37

There is no need to continue this table, which shows approximately the probable error corresponding to any particular value of c, since for any value $c < 90°$ another equation

$$\cos^2 \tfrac{1}{2}c = \cos^2 \tfrac{1}{2}(a+b)+\sin a \sin b \cos^2 \tfrac{1}{2}C$$

is employed, the solution of which is the same and which has this same probable error for values of c from $c = 90°$ to $c = 180°$.

The probability W of an error within certain limits, or of an error within ± 1 second, is computed from the equation [17].

$$W = \frac{2}{\sqrt{\pi}} \int_0^{\frac{\zeta}{\sigma}\sqrt{\frac{6}{\nu}}} e^{-s^2} ds$$

$A > B$, and this difference is sought in the column of the table marked cot. Then from the column marked cos the corresponding logarithm is taken, which subtracted from log A gives the required log C. But if $B > A$ the difference log B − log A is to be sought in the cot column and the corresponding logarithm from the cos column is to be subtracted from log B. That difference is always taken which is the logarithm of a quantity greater than 1, and the corresponding logarithm from the cos column subtracted from the greater of the given logarithms. In the computation of the probable error the rule is so used that for $\mu > 45°$ the change is made from cotangent to sine.

*0.38 in the original. E. F. C.

Now, since

$$\frac{\zeta}{\sigma}\sqrt{\frac{6}{r}}=\frac{\zeta\rho}{wF},$$

let the limit be put for ζ and the probable error for wF, and the value of W corresponding to the argument $\frac{\zeta}{wF}$ may be sought in a table of this integral.

If for example the greatest value found above (0.37) is put for wF, and $\zeta = 1$, then the tables of the integral show for the argument $\frac{1}{0,37}$ the corresponding value $W = 0.93$, or, in other words, under the most unfavorable condition ($c = 90°$) there are 93 errors out of 100 which are less than one second.

B. As another example take the equation which is commended in many mathematical works,

$$\sin^2 \tfrac{1}{2}c = \sin^2 \tfrac{1}{2}(a+b) - \sin a \sin b \cos^2 \tfrac{1}{2}C$$

Its solution is as follows: first from the equation:

$$\cos\mu = \frac{\cos \tfrac{1}{2}C \sqrt{\sin a \sin b}}{\sin \tfrac{1}{2}(a+b)}$$

the auxiliary angle μ is computed, then c from the equation

$$\sin \tfrac{1}{2}c = \sin \tfrac{1}{2}(a+b) \sin\mu$$

Since log cos μ is computed by means of four logarithms taken singly from the tables, we shall have

$$f(\log\cos\mu) = f'_1 + \tfrac{1}{2}f'_2 + \tfrac{1}{2}f'_3 - f'_4$$

in which f'_4 belongs to sin $\frac{1}{2}$ $(a + b)$. Thence it follows that

$$f(\log \sin \mu) = -\cot^2\mu(f'_1 + \tfrac{1}{2}f'_2 + \tfrac{1}{2}f'_3 - f'_4) - \cot^2\mu f''_1 + f'_5$$

$$f(\log \sin \tfrac{1}{2}c) = \frac{1}{\sin^2\mu}f'_4 - \cot^2\mu(f'_1 + \tfrac{1}{2}f'_2 + \tfrac{1}{2}f'_3 + f''_1) + f'_5$$

$$f(c) = \frac{2r}{m}\tan \tfrac{1}{2}c \cdot \left\{f(\log \sin \tfrac{1}{2}c) + f'_5\right\}$$

Then if, instead of f' and f'' we put

$$\tfrac{1}{3}(1)+\tfrac{1}{3}(2)+(3) \text{ and } \tfrac{1}{3}(4)+\tfrac{1}{3}(5)$$

we shall have nineteen independent sources of error and find that

$$\sqrt{\Sigma(\alpha^2)} = \frac{2r}{m} \tan \tfrac{1}{2}c \sqrt{(1,68 \frac{1}{\sin^4\mu} + 3,20 \cot^4\mu + 2,36)}$$

Lastly by inserting the factor

$$10^{-6} \frac{\rho}{\sqrt{6}} =$$

we shall obtain the probable error by which c is affected, as expressed in the following table:

μ	$wF(c)$	
0°	∞	
10	13,286	tan ½c
20	3, 243	"
30	1, 409	"
40	0, 799	"
50	0, 519	"
60	0, 412	"
70	0, 335	"
80	0, 377	"
90	0, 372	"

Since wF approaches infinity as μ approaches zero, this formula is eidently unsuitable for general use.

C. The Gaussian equations for computing the third side c furnish another example. They are the following four, if we put

$$\tfrac{1}{2}(A-B) = \mu \text{ and } \tfrac{1}{2}(A+B) = \nu$$

viz:

$$\begin{aligned}
\sin \tfrac{1}{2}c \sin \mu &= \sin \tfrac{1}{2}(a-b) \cos \tfrac{1}{2}C \\
\sin \tfrac{1}{2}c \cos \mu &= \sin \tfrac{1}{2}(a+b) \sin \tfrac{1}{2}C \\
\cos \tfrac{1}{2}c \sin \nu &= \cos \tfrac{1}{2}(a-b) \cos \tfrac{1}{2}C \\
\cos \tfrac{1}{2}c \cos \nu &= \cos \tfrac{1}{2}(a+b) \sin \tfrac{1}{2}C.
\end{aligned}$$

The order in which the logarithms are written is as follows:

1.	$\sin \frac{1}{2}(a-b) \cos \frac{1}{2}C$	5.	$\cos \frac{1}{2}(a-b) \cos \frac{1}{2}C$
2.	$\sin \frac{1}{2}(a+b) \sin \frac{1}{2}C$	6.	$\cos \frac{1}{2}(a+b) \sin \frac{1}{2}C$
3.	$\cos\mu$	7.	$\sin\nu$
4.	$\sin \frac{1}{2}c$	8.	$\cos \frac{1}{2}c$

Lastly from the difference of the logarithms of 4. and 8. arises log tan $\frac{1}{2}$ c, by means of which the side c is found. But since the angles μ and ν, which are used here only as auxiliaries, have but a small influence upon the probable error by which c is affected, as already has appeared in example A, the formula may be simplified. As the transition has taken place in angle μ from tangent to cosine, in angle ν to sine, we shall write in place of them 0° and 90° respectively. Nevertheless we could pursue a different method without causing any essential difference in the final formula.

Furthermore, if the errors by which log cos $\frac{1}{2}$ C and log sin $\frac{1}{2}$ C are affected be denoted by f'_1 and f'_2, and the errors of the other logarithms, which are used only once in the computation, by f'_3, f'_4, etc., we shall have

$$f(\log \tan \mu) = f'_1 - f'_2 + f'_3 - f'_4$$
$$f(\log \cos \mu) = -\sin^2\mu(f'_1 - f'_2 + f'_3 - f'_4) - \sin^2\mu f'_1 + f'_5$$
$$f(\log \sin \tfrac{1}{2}c) = f'_2 + f'_4 - f(\log \cos \mu)$$

then

$$f(\log \tan \nu) = f'_1 - f'_2 + f'_6 - f'_7$$
$$f(\log \sin \nu) = \cos^2\nu(f'_1 - f'_2 + f'_6 - f'_7) + \cos^2\nu f'_2 - f'_6$$
$$f(\log \cos \tfrac{1}{2}c) = f'_1 + f'_6 - f(\log \sin \nu)$$

lastly

$$f(\log \tan \tfrac{1}{2}c) = -f'_1 + f'_2 + f'_4 - f'_6 - f(\log \cos \mu) + f(\log \sin \nu)$$

whence it follows that

$$f(c) = \frac{r}{m} \sin c \left\{ f(\log \tan \tfrac{1}{2}c) + f'_8 \right\}$$

If in this formula we substitute the values already found, and put $\mu = 0°$, $\nu = 90°$, and for f' and f'' the values found in § 12, it will be seen that $f(c)$ depends on twenty sources of error and that

$$\sqrt{\Sigma(\alpha^2)} = \frac{r}{m} \sin c \sqrt{10,76}$$

This value being substituted in

$$wF(c) = 10^{-6} \frac{\rho}{\sqrt{6}} \sqrt{\Sigma(\alpha^2)}$$

it follows that

$$wF(c) = 0,''3033 \sin c$$

or $w F(c)$ will have the values shown in the following table:

c	$wF(c)$
0°	0,''00
10	0, 05
20	0, 10
30	0, 15
40	0, 20
50	0 23
60	0, 26
70	0, 29
80	0, 30
90	0, 30

Thus it appears from this computation that the probable error is a little less than in the formula proposed under A, but the computation itself is longer on account of the auxiliaries, which moreover are in this case of no further use.

D. Lastly it is advisable to examine some equations in which functions of the entire angles are used in computing triangles.

Let us begin with the equations

$$\begin{aligned} \sin c \sin A &= \sin a \sin C \\ \sin c \cos A &= \cos a \sin b - \sin a \cos b \cos C \\ \cos c &= \cos a \cos b + \sin a \sin b \cos C \end{aligned}$$

and put

$$\begin{aligned} \sin a \cos C &= m. \sin M. \\ \cos a &= m. \cos M. \end{aligned}$$

Then we shall have

$$\begin{aligned} \sin c \sin A &= \sin a \sin C \\ \sin c \cos A &= m \sin (b-M) \\ \cos c &= m \cos (b-M) \end{aligned}$$

Hence in order to find c there must be computed

$$\tan M = \tan a \cos C$$

$$\tan A = \frac{\sin M}{\sin (b-M)} \tan C$$

$$\tan c = \frac{\tan (b-M)}{\cos A}$$

Accordingly we have

$$f(\log \tan M) = f'_1+f'_2$$

$$f(M) = \frac{r}{m} \sin M \cos M (f'_1+f'_2+f''_1)$$

$$f(\log \sin M) = \cos^2 M (f'_1+f'_2+f_1'')+f'_3$$

$$f(\log \sin [b-M]) = -\cot (b-M) \sin M \cos M (f'_1+f'_2+f''_1)+f'_4$$

$$f(\log \tan [(b-M]) = -\frac{\sin M \cos M}{\sin (b-M) \cos (b-M)} (f'_1+f'_2+f''_1)+f'_5$$

$$f(\log \tan A) = f(\log \sin M) - f(\log \sin [b-M])+f'_6$$

$$f(\log \cos A) = -\sin^2 A \left\{ \begin{matrix} f(\log \sin M)-f(\log \sin (b-M) \\ +f'_6+f''_3 \end{matrix} \right\} +f'_7$$

$$\begin{aligned} f(\log \tan c) = & -\frac{\sin M \cos M}{\sin (b-M) \cos (b-M)} (f'_1+f'_2+f''_1)+f'_8 \\ & +\sin^2 A \cos^2 M (f'_1+f'_2+f''_1)+\sin^2 A \cdot f'_9 \\ & +\sin^2 A \cot (b-M) \sin M \cos M (f'_1+f'_2+f''_1) \\ & -\sin^2 A \cdot f'_4+\sin^2 A \cdot f'_6+\sin^2 A \cdot f''_3-f'_7 \end{aligned}$$

finally

$$f(c) = \frac{r}{2m} \sin 2c \left\{ f(\log \tan c)+f''_3 \right\}$$

Then if we put the side $b = 90°$ in order to simplify the computation and to obtain a representative value from which the others differ but little, the formula $f(c)$ is changed as follows:

$$f(c) = \frac{r}{2m} \sin 2c \begin{Bmatrix} -\cos^2 A\,(f'_1+f'_2+f''_1)+f'_3-f'_7+f''_3 \\ +\sin^2 A\,(f'_2-f'_4+f'_6-f''_3) \end{Bmatrix}$$

Then, after we have written for the various quantities f' and f'', their values according to § 12 there are seen to be 27 sources of error, and

$$\sqrt{\Sigma(\alpha^2)} = \frac{r}{2m} \sin 2c \sqrt{4{,}04 \cos^4 A + 5{,}72 \sin^4 A + 4{,}04}$$

whence it follows that

$$wF(c) = 10^{-6} \frac{\rho}{\sqrt{6}} \sqrt{\Sigma(\alpha^2)}$$

The values of $w\,F\,(c)$ corresponding to different values of A will be

A	$wF(c)$	
0°	0,'1314	sin 2c
10	0, 1293	"
20	0, 1215	"
30	0, 1193	"
40	0, 1170	"
50	0, 1196	"
60	0, 1276	"
70	0, 1353	"
80	0, 1419	"
90	0, 1444	"

If instead of the factor which depends on A we put the constant 0.13 14 we shall have

c	$wF(c)$
0°	0,"00
10	0,"04
20	0,"08
30	0,"11
40	0,"13
50	0,"13
60	0,"11
70	0,"08
80	0,"04
90	0,"00

The maximum value of the probable error will here be $\frac{1}{4}$ of a second, while in the formulas considered under A and C it was $\frac{1}{3}$ of a second. Furthermore, as long as c has a value less than 45°, formulas A, C, and D are affected with nearly the same error, but for greater values of c the last equations are evidently to be preferred.

These examples may suffice to show the use of the formulas proposed above. Space does not permit the continuation of this subject in this place, but its further study may be strongly urged upon those who are required to make frequent use of formulas, as in astronomy. In general it will appear that a slight change in a formula will sometimes bring about a very great difference in precision, as examples A and B show; and furthermore, that the computation in which the functions of whole angles are used, such as was proposed in D, usually affords greater precision than if functions of the half angles were used, although usually at the cost of a greater expenditure of time. The determination of the probable error ought never to be omitted in actual practice since the following formulas:

$$\tan M = \tan a \cos C$$

$$\cos c = \cos a \frac{\cos (b - M)}{\cos M}$$

which are recommended in many mathematical books instead of those which we have examined under D, ought not to be used

except with great circumspection and within proper limits. These limits having been found by an investigation of the probable error, such a formula, although useless elsewhere, can be used conveniently in the cases and within the limits where it offers the advantage of brevity and still affords sufficient precision.

PERSONAL NAMES:

THEIR SIGNIFICANCE AND HISTORICAL ORIGIN.

JAMES DAVIE BUTLER, LL. D.

"Go to pot, I tell you, Sir, go to pot!" These words were my greeting from the head of the Boston public library when I began to seek there for the significance of personal names. His language was brusk and would have sounded contemptuous to a stranger. But he had been my classmate a decade before and had taken as many jokes as he had given. His meaning was; The best book in Boston to tell you what your name means is a volume by Augustus Frederick Pott. Its full title is; Die Personennamen; insbesondere die Familien-namen und ihre Entstehungarten, auch unter Berücksichtigung der Ortsnamen.

This work published in 1853 is by no means antiquated. It is larger than any one of the twenty volumes on the subject in our Historical Library,—and though each of those more recent works has points of superiority,—no better advice can now be given to a beginner in patronomatology than "Go to Pott, I tell you, Sir, go to Pott!"

My friend's jocular order, however, led me to tell him a trifle of my earliest experience in the Paris police-office when passports were a daily necessity. Ushered into a long hall where a score of clerks were writing on each side, I walked up to the nearest one, passport in hand, wishing to get it *vised.* He glanced up at me from his desk, and said O Booh! paying me no further attention. I passed on to another writer who also said O Booh! and nothing more. I turned across the room but heard no other salutation. O Booh to right of me, O Booh to

left of me, O Booh behind me, volleyed and thundered. At last it dawned on my darkness that no insulting English vocables were in the minds of the vociferators but that they were only informing me that I must go to the *end* of the office, *au bout!*

No theme so comes home to all men's business and bosoms as personal names. Some savor of their significance pervades all literature sacred and profane—downward from the Bible and Homer. The earliest family quarrel we read of was when an Attic farmer who never spent anything had taken a wife who counted nobody respectable that did not keep a horse. In naming their first boy he insisted on a name with the element *saving* in it, while she would hear of none which lacked the syllable *horse*. By way of compromise the name Pheidippides, that is *son of a saving horse* was invented and adopted.

Personal names being then of such varied interest cosmopolitan, pre-historic, post-historic, con-historic, sub-historic, no one should essay to treat the general subject in fewer pages than the thousand of Pott, indeed were Pott now writing and in regard to our American poly-glott and panti-glott directories his book would become doubly ponderous.

Broadly speaking personal names may be said to be derived from three sources, namely, first, some characteristic, actual, imagined or ascribed, secondly, one's occupation, and thirdly, his place of abode. Before tracing a name, however, to any one of these sources we must often ascertain the meaning of obsolete words or forms of words in our own tongue, or study foreign languages, or become conversant with many varieties of industry now no longer known or carried on by new processes.

In the following article the names chosen for illustrating the subject are of persons well known in Madison, but those of people in any other town or those of authors on the backs of books in any library would have been equally serviceable for the writer's purpose.

The earliest personal names were naturally given in view of some personal *characteristic*.

Hence originated the first Fairchild and the first Brown. Morris, that is Moorish, is another name for *dark brown*.

Adams and Reid—both mean *red*—the one being Hebrew and the other Scotch. Russell as a diminutive of red we may define as *ruddy.* So Julius as well as La Follette means *soft hair,* and Favill, as some think, is *yellow hair.*

Greeks called one man Eustace that is *well-put-together,* or Andrew meaning *manly,* Jews called him Asahel, that is *God-made,* Saxons called him Charles and Irish Bryant, both meaning *stout.* A similar idea of physical prowess led to such names as Storm Bull, Buell also meaning *bull,* Hoyt, *nimble,* Bjorn, a *bear,* Oscar, an *agile warrior,* Martyn, *Mars-like,* Knapp, *a striker.*

Other names were indicative of *mental* qualities. Hugh was a *thinker,* Hutchinson and McKee both signify sons of Hugh. Hubert was *bright* Hugh, and so Albert is *all-bright.* Robert *fame-bright* and Herbert, *army-bright,* Gilbert, *bright servant* whose son became Gibson, Gib being a contract of Gilbert. So Aubertine was *white-bright* or perhaps *self-bright.* Hobbs and Hobbins are possibly allied to Robert, i. e., *fame-bright.*

Such of our personal names as do not show location or characteristics, are descriptive of *occupation.*

Among the most ancient of this class is Therese. This name is Greek and means either *huntress* or *female harvester.* Birge if not birch, may be French for *shepherd,* (Berger) in pastoral poets, a rustic *lover.* Birge is, however, more probably a contract from early English Her-*berg*-ere, meaning harborer, that is *innkeeper.* George is Greek for earthworker, that is *farmer,* which in German is Myers, in old English it is Bower and Burr. Gregory is Greek for *watchman,* not unlike Ward in English. Edward is a guard of *goods,* and Woodward of *trees,* and akin to Forster [forester]. The London Bunhill was named from a *cake,* and the proper name Bunn would seem to mean the maker or seller of that dainty.

Among occupational names which are plain of themselves we have Mason, Carpenter, Turner, and Bowman. Homer is set down as helmeter, that is *helmet-maker,*

Smith, is a *smiter,* and his monosyllabic name may be a survival of some compound, as Arrowsmith, Bowsmith, Blacksmith, Whitesmith, Gunsmith, Goldsmith, Silversmith, Song-

smith [poet]. It is owing to countless defunct compounds that Smiths are multitudinous. Baird is a poet, being Scotch for *bard.*

All patronymics—or names showing men's fathers, are in a loose sense characteristic. Such are all names ending in son, as Carson, son of Carr; many that end in *s* as Hobbs, all that begin with Mc, and some that begin with B. Thus, Bolivar is the son of Oliver, and Breese the son of Reese, or Rice. This Welsh word Rhys is of cognate origin with the Latin *rex,* a king. Characteristic names when given to children betokened qualities not always possessed—but attributed by parental affection, or hoped for. Rasmus, contracted from the Greek Erasmus,—in Latin Desiderius—one *longed for* and hence *loved,* is identical in significance with David and Davie in Hebrew (with Taffy as a variant), and Cary in Irish. A similar feeling led Leah at the birth of her first-born to exclaim, "Reuben!"—that is *behold a son!* Where primogeniture was law it was common to call the oldest boy Barnes, that is *the bairn*—the child by way of eminence as the predestined heir. In astrological eras as the hour of birth was held to have a life-long influence, and those born at dawn were destined to good luck, a boy born then was named Lucius or Lucien, that is, belonging to *light,* and so of good omen. Hence arose the Latin proverb *Nomen omen.*

Parental appreciations—sometimes exaggerations—of babes in the house, are to be credited with such names as Theodore, i, e., *gift of God;* John and Jones, *God's grace,* the most pervasive name in Christendom, leaving no corner of it untouched. On the same lines were formed Margaret—*a pearl,* Rosella—*a little rose,* Romanzo—*a fairy tale,* Anna—*condescending,* Augustus—*dignified,* Stevens—*crowned,* Emil—*emulous,* Edwin—*a lucky winner,* Willard—*strong will,* Elizabeth—*devout,* Delia—*chaste* from a name of the Grecian Artemis, Gold—the most precious of all metals and as too many think of all things—Stearns—*a star,* though some interpret it "*stern,* from the natural disposition of the first bearer."

Other names characterize still less flatteringly. Thus the Irish called Cassoday [Cassidy] an *accuser* or caviler, Jacob as well as its variant James is a *heeler,* heel-catcher, because the

patriarch at first seized his brother by the heel (Gen., 25, 26), and afterward tripped him up; and Favill in old English was a *liar* or at least a fabulist. Says Chaucer:

> "Looke on the luft-hond, and see wher he stondeth
> Both fals and fauvel, and all his hole meyne."

Names suggested by temperament are frequent. Thus, a sanguineous daughter was called Ella—that is, *sunny;* Allen, if it was not at first a hound, *All-win,* as if he had won all, meant *cheerful;* Isaac meant *laughter,* for he was the cause of it; Mary—in Latin, Maria—was tearful, and so was well named *bitter.* The same sense I find assigned to the first Hervelin who was born blind, and so to a *bitter* life.

Other characteristic appellations allude to some exploit historic, or prophetic, or hoped for. Thus, Daniel is *divine judge;* Uriah, *light of God;* Joseph, *augmentation;* Jairus, *enlightener;* Alexander, *helper of men;* William, *helmet of many;* Louis, *bold warrior;* Pringle, *pilgrim.* Oliver—so called from complexion, or as living by an olivet—long meant *peaceful,* with a reference to the olive branch of Noah's dove. But becoming confused with Olaf, the old Norse fighter, it came to mean a *champion* whom no one but Roland could match. Hence the phrase, Give a Roland for an Oliver. Henry means *home-ruler;* Hanks, Haskins, and Hendrick are some of its variants, though Lower says Hanks means *house-wolf* (p. 146). Frederick is *peace-ruler;* Richard, *great heart;* Willard, *strong will;* Sarah is *mistress.* Noble explains itself, and also Eugene, which is Greek for *well-born.* Freeman describes a man who first among a crowd of serfs broke his birth's invidious bar, and so was known by way of distinction as *the* freeman.

Another class of personal names denotes *location*—the place of origin or abode.

Jastrow comes from a Polish town so called in the present province of Posen. Brandenburger is a name given to one who originated in that German region of which Berlin is the capital, and Frankenburger denoted one who came from an imperial circle now in Bavaria. The name Lincoln showed that a man had to do with the English county of that name. Orville

and Favill, if French, may mean: the one a town of gold, and the other a suburb. Ely and Ramsay indicate islands, the one of *eels* and the other of *rams*, as Shelly points to an isle of *shells*. Pinney is isle of *pins*, a word which of old included both pegs and underpinning. The name of old was spelled with a y; so was pin, which also had two n's. Such place-names were often first given by outsiders when natives migrated, and in their new homes were thought of in reference to their provenance.

Several names came from connection with trees. Grover, one dwelling by a *grove*, is similar to Atwood. Analogous is Silas, that is, *woodman*, being a contraction of *silvanus*, which is woodman in Latin. So Birge, if English, is probably *birch* wood. Thwaites is a clearing in a wood,—a place where the trees have been *thwacked*. Other names show connection with valleys. Comstock is the clan in a comb—*comb* in old English meaning a valley or the ridge which hems it in. The word honeycomb still shows the ancient meaning. Dalzel is the white dell, and Kendall the dale of kindred.

Newton—*new town*—is self-explaining. Stanley is a field of *stone*. Lansing—the field of a *lancer*—reminds of a Westernism, namely, tomahawk right. Sheldon is hill of shells, and Conover, a cow-yard.

Several local names were given in reference to water. Moore is a *marsh;* so is Kerr, so is Van Hise—Hise being a corruption of *ness*, which is Dutch for a *swamp*, and akin to the German *nass*.

Bashford is the passage of a stream; the first syllable may be *bas* as in Bascom—i. e., *lower* valley, or is it rather a variation of *bush?** Olin, unless his lineage runs back to the Norse Ole, may denote a *pool*,—and especially, one not shallow. Lincoln is a colony beside a pool. Upham is *upper hamlet*, and Updike probably *upon* the *dike*.

The name Wright is the same word as *worker*, the letter r being transposed. It was in usage restricted to a mechanical worker, as *cart*wright, etc. The name Wayne, the old English form of *wain*, or wagon, is still found in the compound, Wain-

*In the British gazetteer I find three places now set down as *bas-ford*, and one as *bas church*.

wright. The name Cole is *collier* abbreviated, and Mills is *miller*. McMynn is Scotch for *son of milner* [miller]; Stuart, that is, *Stow-ward,* is guardian of what is *stowed* in a house. Reeve is a similar term, but with a wider meaning. Thus Chaucer says, Bards, 223:

> "His lordes shepe, his nete and his deirie,
> His swine, his hors, his store and his pultrie
> Were wholly in this *reves* governing."

It is agreed that Butler means *cup-bearer,* but it has been doubted whether his name came from the *bottle* he uncorks or from the *butt* out of which bottles are filled. The name King, apparently signifying the highest of occupations, may really have been an adjunct of the lowest—King's *groom,* scullion or factotum, as King John said (iv., 2, 222) of such tools,

> "Fellows by the hand of nature marked
> Quoted and signed to do a deed of shame."

It seems clear, on the whole, that personal names may all be reckoned to have been at first significant of characteristics, locations, or occupations. As time went on, however, those names were often bestowed without any regard to their original meaning. Christian names were from early ages so given, a fact too little dwelt on by writers on the specialty of names. Church calendars had their beginnings as early as the fourth century. They grew rapidly so that, though every dog has his day, many a saint must be content with none, or at most with a part of one. Each saint was viewed as the tutelar genius—or guardian of all children born on his own day—and so they were naturally often called by his name, with no care for their location, occupation or characteristics. All old almanacs—whatever they lacked—showed at least one saint for every day in the year. Such a list was invaluable. It taught the most ignorant mother in a moment what name it was predestinated her child should bear. This saintly calendar appeared in the first volume of the world-famous *Gotha* Almanac issued in 1776, and it has been repeated every year since. The adoption of names in accordance with the days of saints did not end at the Refor-

mation even in Protestant Europe. The Gotha roster is threefold: one column presents Greek saints, the second Catholic, and the third, equally long, the saints recognized by the Reformers. As often as the Lutherans rejected one of the Catholic band, they filled the gap by inserting another saint, and that usually from the Old Testament. Thus Genevieve was thrown out and Enoch was substituted. This fact shows where many hard Hebrew vocables came from which were fathered upon the Puritans, but have been proved to be older than they, and also prevalent in the church of England. Adam in the Reformed calendar stands for the Catholic Delphine, who was the tutelar of Dec. 24th.

Whatever then the proximate occasion of our being called by the names we bear, it would seem that not a few of them ultimately came to us from the calendar of the saints, often because we were namesakes of god-fathers. Tracing the possible lineage or descent of one single name may shed a side-light on that of others. The name George, as has been stated, means *farmer* and was derived from occupation. It was doubtless common in a region between the Black and Caspian seas which was called Georgia, or land of farmers, to distinguish it from the Nomads or pastoral tribes around. Near there in Cappadocia a certain George slew a dragon and saved an imperilled virgin. This exploit, as some hold rather prosaically, lay in delivering the ground from weeds and enabling it to yield crops. In the view of others, George vanquished the persecutors of the church, of whom the serpent Satan was chief. At all events, George became a saint, one of the seven champions of Christendom, and the patron of knights, and of several countries. In England, his royal chapel—still the finest in the kingdom—at Windsor, was completed four centuries ago. It was in 1349 that St. George had been taken by Edward III., at the siege of Calais, as the national saint of England. His name became the English battle-cry, so in Shakespeare Talbot exclaims: "Saint George and victory, fight, soldiers, fight!" A hundred and sixty-two parish churches have been ascertained to bear his name. His day was the 23d of April, but we may be sure that many a boy born on other days was christened with

this favorite's name. King George the First, who came from Hanover, getting his own name from the saint, passed it on to three of his successors. All the royal Georges unawares spread the name among unroyal scions, as when Calhoun took snuff all Carolina sneezed. Among such plebeian namesakes was George Washington, to whom more Americans proximately owe their first name than to any king or saint.

Several others of our names go back ultimately to notables whom they strive to keep in mind. Alexander is a memorial of a monarch who in 1286 was the Washington, or at least the Lincoln, of Scotland. Lucien was suggested to many a mother by the career of the most irreproachable brother of the first Napoleon. So was Eugene, by Napoleon's step-son Beauharnais, and Bolivar, meaning as already stated, son of Oliver, who, more than any other man, was the liberator of South America. His name has been linked with our greatest name by Byron, who sang:

> "The prophets of young freedom summoned far,
> From climes of Washington and Bolivar."

It is no wonder that political sympathies multiplied his name, Bolivar, among us. Veneration for a most heroic missionary whose sun went down at noon, has given us many a Henry Martin, by adopting his whole name. In remembrance of the first American chief magistrate who died in office, and that on its threshold, more than one cradling was then named William Henry. If Abraham as well as Lincoln appears in the name of a citizen, it is clear that his mother's heart was a shrine of our first presidential martyr. Homer says the infant Astyanax was like a star, and so, no doubt, many an English boy was in the eyes of his mother. Then she had no hesitation about a name for her earth-treading star. Many a Grecian mother must have lulled her babe to sleep with an epigram of Plato's:

> "Thy looks are heavenward to the starry rays,
> Were I that heaven all stars on thee should gaze!"

So she would name him *Star,* or its variant *Sterns.* Should that brightest of stars in her eyes have proved too good to live, she had a still better epitaph, also from Plato:

> **"Thou wert the morning star to all the living**
> **Ere thy young life had sped,**
> **Now, like the evening star, thou 'rt giving**
> **New lustre to the dead."**

Some names represent the ecstasies of young mothers and perpetuate them. One of those blessed women beholding in her infant the best of what she had read in romances realized, called him her romance—*Romanzo.* Another, admiring the Old Testament knight,—most without fear and without reproach, the Chevalier Bayard of the Bible—called her man-child *the light of God,* Uriah. We cannot see the name degraded in the Uriah Heep of Dickens without feeling again as we did when the flag of the Union was hauled down and dragged in the dust. Milton, however, had glorified the name in its variant, Uriel, beyond degradation:

> **"The archangel Uriel—one of the seven**
> **Who in God's presence nearest to his throne,**
> **Stand ready at command, and are his eyes**
> **That run through all the heavens, or down to the earth."**

St. Rasmus—the Christian Castor and Pollux—showing at the mast-head electric flashes welcome to sailors as a light-house, gave Norwegian mothers of sea-farers a name that was above all other names. That corposant lighted vikings to many dark deeds. In the Italian Rasmus is spelled St. Elmo, and gives name alike to Neapolitan sailor boys and to the high-gleaming castle at Naples which is their land-mark, or sea-mark.

This lucubration began with Dr. Pott, and it may well end with him. I repeat it then: Go to Pott! Pott, starting with his own family name, passed on to the study of all personal names and then to comparative linguistic research, rising still from high to higher until he became one of the most illustrious philologists of his time, and some would maintain of all time; as Germans say, a path-breaker and epoch-maker.

We may naturally gain some analogous impulses from the

study either of our own names or those of those with whom we are most familiar. The habit of letting no word pass from us without analysis will give us always and everywhere food for thought and speech. It will satisfy us that in properly studying words we must study things. Botany turns in the eyes of its votaries every weed into a flower. Linguistics transform every vocable, no matter how trite or trivial. They show our commonest phrases to be carrier-doves flying through all ages and continents bearing on their wings a flavor of poetry, history, philosophy, religion. Thus they become veritable birds of paradise regained.

DEVELOPMENT AND STRUCTURE OF THE SWARM-SPORES OF HYDRODICTYON.

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Of the various large groups of plants the green Algae, with the possible exception of *Spirogyra,* have perhaps been the least investigated from the modern standpoint of cell structure and by aid of the newer technique. The special problems that need careful attention are connected with the method of cell division, the structure and division of the nuclei and the development and structure of the swarm spores.

Until very recently the prevailing accounts of cell division accompanying spore formation in many of the coenocytic Fungi and green Algae agreed that the protoplasm is divided at once into uninucleate segments. But the researches of Harper (11, 12) upon *Synchitrium, Pilobolus, Sporodinia and Fuligo* showed that many stages of cleavage in these forms had been entirely overlooked by previous observers. Harper showed that in the forms enumerated instead of the cleavage being simultaneous it is progressive in that the protoplast becomes divided into large multinucleate masses that are further divided into uninucleate ones. There is, moreover, quite a variation in the manner in which this process of progressive cleavage may be accomplished. It may be done by means of constriction furrows in the plasma membrane alone, as for example, in *Sporodinia* or by means of constriction furrows which fuse with angular vacuoles on the inside of the protoplast as is the case in *Pilobolus.* Analogous processes may be expected to occur in the spore forming cells of the coenocytic Algae. Klebs (16) has, in fact, described a process of progressive cleavage

in *Hydrodictyon* but, as will appear later, without giving a full or accurate account of the important details. Klebahn (15) has also briefly described a similar process in *Sphaeroploea annulina.* In this case irregular clefts are said to arise in the protoplast and by further growth and branching to separate it into the final cleavage products. The origin of the clefts Klebahn does not describe.

To Schmitz (21) and Strasburger (23) is due the credit for establishing the presence and permanency of numerous nuclei in many lower Algae, especially such forms as *Hydrodictyon, Cladophora,* etc., as well as many of the lower Fungi, but the structure and division of the nuclei so far as the coenocytic green Algae are concerned, are practically unknown with the exception of Fairchild's (8) work on *Valonia* and more recently that of Klebahn on *Sphaeroploea.*

In Fairchild's account of nuclear division in *Valonia,* there is described and plainly figured for the first time stages showing very clearly that the mitotic division in that plant is similar in its essential features to the nuclear division in the higher plants and animals.

The chromatin collects into a thread and segments into chromosomes that are collected into an equatorial plate. The daughter chromosomes are drawn to the poles of the spindle where they form the daughter nuclei in a manner similar to that observed in most cells. The method of spindle formation was not made out in detail, but at the time of the formation of the equatorial plate the fibres were seen to converge at two points on opposite sides of the nucleus. Whether centrosomes are present Fairchild could not definitely determine, but his figures show quite well defined bodies at the poles of the spindle. Around these bodies numerous short rays radiate forming apparently quite typical asters.

The nuclear membrane persists, according to Fairchild, until the anaphases in which it is drawn out into a long sac like structure between the two daughter nuclei. Fairchild saw no trace of the central spindle fibres in connection with this sac like structure. The fact that, in *Valonia,* amitotic nuclear division may occur in the same cell with the mitotic divisions

seems to have also been clearly established by Fairchild's researches.

Klebahn's figures of *Sphaeroploea* show by the presence of a well defined spindle and distinct chromosomes that in that alga the nuclei divide by a typical mitotic process.

Golenkin (10) has recently studied the nuclei of various green algae and has attempted to show that the nuclei in such forms as *Hydrodictyon* and *Sphaeroploea* correspond in structure to those in *Spirogyra* in that in the resting stage the chomatin material is collected in the middle of the nucleus in the form of a large nucleole. Between this body and the nuclear membrane the space is filled with a formless hyaline substance. During the division stages the bodies corresponding to the chromosomes of higher plants are differentiated out of the central nucleole-like mass. Golenkin thinks that this type of nucleus is of a primitive character as indicated by its occurrence in these lower forms, but it is quite probable that Golenkin worked with poorly prepared material in which the nuclei were distorted. Such a result can easily happen in connection with forms whose nuclei are so small as those of Hydrodictyon. But my figures show that the nucleole in this plant is the same organ in structure and occurrence as it is in the nuclei of the higher organisms.

The discovery of special cilia forming organs in the antherozoids of various Gymnosperms and Pteridophytes, by Webber (33), Ikeno (14), Hirase (13), Belajeff (3), and Shaw (22) and the attendant discussion as to their homology has brought into prominence the question as to the homologies of cilia bearing organs in swarm spores and other ciliated cells.

In a paper on the *Chlamydomodineae,* Dangeard (6) discusses at some length the question of the structure of the cilia bearing organ in the swarm spores of those plants. He thinks that the cilia are attached to a small basal nodule just within the plasma membrane. There extends from this nodule toward the nucleus, according to Dangeard, a fine protoplasmic fibre, that may or may not reach the nuclear membrane. The basal nodule is thought by Dangeard to be equivalent to the blepharoplast of the antherozoids of the Gymnosperms and ferns.

Strasburger (25) has recently discussed very fully the question as to the structure and homology of the cilia bearing organs of the swarm spores of such forms as *Cladophora, Vaucheria* and *Oedogonium.* He thinks that there is a simple swelling of the plasma membrane at the point of insertion of the cilia, and that this is neither a centrosome nor the equivalent of the blepharoplast. Strasburger contends that the entire "mouth piece" of the swarm spore of *Oedogonium* is to be regarded as the homologue of the cilia bearing band of the antherozoids of the Gymnosperms and ferns.

Dangeard (7) has attempted to establish homologies between the structure of the swarm spores and gametes of the *Chlamydomodineae* and *Polytoma uvella,* and the spermatozoa of the higher animals. But he fails to show that the development of the structures that he thinks are homologous is in any way similar.

The main features in the morphology and reproduction of *Hydrodictyon* have become well known through the researches of Vaucher (3), Areschoug (1), Braun (4), Pringsheim (20), Suppanetz and others. A very complete historical account of these researches is given in Artari's (2) paper referred to below, so that I shall take account of those papers only that have a direct bearing upon the problems here investigated. The most accurate and complete account given by the earlier observers of the cell structure and method of spore formation was that of Braun (6).

According to this observer the protoplasmic contents of the cell consist of three distinct layers: 1. The "primordial membrane," a thin, somewhat opaque layer appearing finely punctate which is drawn away from the cell membrane by the action of acids. 2. An outer "mucilaginous" layer, which is thicker than the preceding, but thinner than the following layer. It appears to be irregular on the outer and inner surfaces and contains numerous "mucilage granules" (nuclei?) which are somewhat large and irregular in outline. 3. "Inner mucilaginous layer"—the thickest layer of the three containing the chlorophyl which in young or poorly developed cells appears in irregular rows of small granules forming a network,

but in old, well developed cells is evenly distributed. This layer also contains starch vesicles (pyrenoids) that project into the central vacuole on the inside.

While the above description lacks many important details and is in error as to the differentiation of the protoplast into layers, it is notable that later observers using the same methods as Braun, have made very little advance beyond the results he obtained as to the structure of the cell contents.

The cell wall is also, according to Braun, composed of three layers as follows: 1. An outer, thin cuticle. 2. A middle thick layer, that swells strongly in sulphuric acid and stains blue with iodine. 3. An inner layer that swells so as to become the thickest of the three when treated with sulphuric acid and to present wavelike folds on the inner surfaces.

In the account of the spore formation Braun described only some stages that belong to the later phases of the cleavage of the whole protoplasmic mass. He determined, however, that preliminary to the beginning of the process the pyrenoids (starch vesicles) disappear. The first stage of cleavage consists, as he described it, in the appearance in the protoplasm, of numerous light spots equidistant from each other between which the granules of chlorophyl arrange themselves in rows. This stage is followed by one in which the granules retreat toward the clear spots, leaving transparent lines that mark off hexagonal areas on the surface. Each mass thus formed finally becomes a spore. The transparent lines are supposed to be of some substance that separates the hexagonal masses, and is dissolved during the subsequent process of the complete separation of the spores, when the lines disappear except for triangular spaces between the rounded masses.

After a period of rapid movement inside the mother cell wall the swarm spores come to rest and form a new net. The pyrenoids begin to appear immediately after the swarm spores have come to rest. Braun held that their origin was entirely *de novo* and that they were never multiplied by fission.

In some cases swarm spores were observed which had two or more pairs of cilia. This was accounted for by the non appearance of the light cleavage lines in an earlier stage. It is to

be noted that Braun failed to distinguish the nuclei as such. It is quite probable, of course, that the light spots that he speaks of were the nuclei, but it would be hard to always distinguish them in living material.

In material fixed in alcohol and stained with haematoxyline, Strasburger (23) was able to distinguish, in the protoplasmic layer of the cell, numerous small nuclei which he thought divided just prior to cleavage. Strasburger bases his account of the rest of the process of cleavage entirely upon the observations of Braun and Cohn (5) as their descriptions agreed well with his account of simultaneous cleavage in many other coenocytic cells of the Algae and Fungi.

In 1890 Artari (2) attacked the special problem of the significance of the nuclei in the process of cleavage and also gave considerable attention to the structure of the chromatophore. He thought that the chromatophore is in the young cell an irregular plate like body with long projections similar to the chromatophore of *Draparnaldia.* During the growth of the cell the projections bend over and fuse so as to form a net which by increase in extent of its parts becomes a perforated plate on the inner side of which the nuclei lie. In material fixed in picric acid and mounted in glycerine or Canada balsam Artari was able to make out that each nucleus contained a prominent central nucleole. Farther than this, however, no details of nuclear structure were described. Cleavage begins, according to Artari, by the division of the chromatophore into irregularly hexagonal areas each of which contains a single nucleus. These areas are separated by a transparent plasma corresponding to the light lines of Braun.

It will be seen from the above paragraph that Artari's account of the cleavage process differs in no important particular from that of Strasburger. His description of the development of a distinct chromatophore is, as I have pointed out in another place, based upon inadequate means of observation, due to his methods of treating the material. The apparent similarity of the chromatophores of such a form as *Draparnaldia* to the chlorophyl containing cytoplasm in the young cells of *Hydrodictyon* might easily lead one to the conclusion that chro-

matophores of similar structure were being observed in the two cases provided only surface views were studied. Artari does not attempt to solve the problem as to the mechanism by which the so-called chromatophore is divided. His account of the cleavage process is no doubt influenced by the conception of the *Vollzellbildung* of Strasburger in connection with numerous other forms as noted above. That he observed only the later stages in the process is evident from the work of Klebs and the figures that I have shown in this connection.

Klebs (16) gave a very complete account of the appearance of the *Hydrodictyon* cell under various conditions and described the process of cleavage as taking place in a manner entirely different from that described by previous observers. Klebs, however, like his predecessors, limited his observations to surface views of the material for the most part in the living condition. He confirms Braun's statement that there are three distinct layers of protoplasm in the cell, but identifies the outer as the *hautschicht* and the inner as the vacuolar membrane or *tonoplast* of De Vries, leaving the middle layer occupied by the chromatophore and the layer of protoplasm containing the nuclei. Klebs' account of the structure of the chromatophore is essentially the same as that of Artari. He thinks that while this is a distinct chromatophore it is of a low order of organization since it is merely passive during the process of cleavage and shows at no time the initiative power of reproduction. The nuclei are said by Klebs to occupy no definite position with reference to the pyrenoids, but to appear in the openings through the chromatophore as if lying deeper in the protoplasm. They are described as vesicular structures each having a single large central nucleole. The nuclei, like the pyrenoids, are connected by special strands of protoplasm forming a network with the nuclei at the angles of the meshes.

The process of cleavage begins, according to Klebs, by the formation of angular, in some cases almost canal like, vacuoles in the middle layer of protoplasm. The vacuoles fuse with one another so as to cut the protoplasm, including the chromatophore, into large irregular pieces which, by constriction or by further branching of the vacuoles, are cut into smaller pieces

until the whole protoplast is divided into uninucleate bodies whose mutual pressure gives to each a hexagonal shape. The hexagonal bodies appear to be separated by light lines. This appearance is caused, as Klebs rightly observes, by the two limiting layers of protoplasm being pressed together. This is the condition described by Strasburger and Artari as the earliest stage in the division of the cell. At no time, according to Klebs, do the cleavage vacuoles cut through either the plasma membrane (hautschicht) or the vacuolar membrane of the mother cell. Klebs thinks that the cleavage is never complete but that the swarm spores always remain attached to one another by thin strands of protoplasm, which only disappear after the spores have come to rest and the new walls are formed around the young cells.

From the fact that in many cells the number of nuclei is greater than the number of swarm spores that could be formed from the same cells, Klebs suggests that there must be a fusion of the nuclei in such cases prior to the completion of the cleavage. The observations of Braun and others of the disappearance of the pyrenoids prior to cleavage is confirmed by Klebs.

I have published elsewhere a brief resume of some of the main facts described in the following pages. (28) The material with which I have worked was collected in the vicinity of Madison, Wisconsin, from small, slow flowing streams or in protected portions of the lakes surrounding the city. The plants were generally brought into the laboratory in large quantities and placed in aquarium jars in well lighted places. No attempts were made to use special culture conditions for the production of swarm spores but it was often found that they were produced within a few days after the collection of the material. This phenomenon, however, was by no means constant and very frequently material was kept in the laboratory for many days without showing any signs of spore formation. Very often cultures growing under diverse conditions of light and temperature would all be producing swarmspores at the same time. I have not succeeded in finding any material producing swarmspores when collected, but in some

lots new nets apparently under twenty-four hours old were observed.

The difficulties in getting well fixed material of such alga cells as those of *Hydrodictyon* possibly help to account for the fact that so few investigations have been carried on in this group of plants by means of modern cytological methods. The relatively thick and impervious cell walls and thin layers of cytoplasm combined with a large central vacuole present a set of conditions under which fixation without shrinkage and consequent distortion of the plasma contents is hard to accomplish. A solution must be found that will readily penetrate the cell wall and plasma membrane and thus fix the cells without distortion. The two solutions that I have found to best answer these conditions have been Merkel's platinum chloride chromic acid mixture and a mixture of iridium chloride and acetic acid. Two formulas were used for this latter combination; one that of Eisen consisting of 100 parts, five-tenths per cent iridium chloride in distilled water and 1 part glacial acetic acid; and a stronger solution consisting of 100 parts of 1% iridium chloride in distilled water and 3 parts glacial acetic acid. Very little difference could be detected in the effects of the two iridium-chloride-acetic acid mixtures, although the stronger was generally more reliable for fixing the finer details of structure, especially in the nuclei.

As between the Merkel's solution and the iridium chloride acetic acid mixture, the latter is to be preferred for cases where very delicate structures are to be dealt with, such, for example, as the comparatively young cells of *Hydrodictyon* where the layer of protoplasm is very thin and its finer structures very easily destroyed. Still both solutions are very satisfactory and I have tried them on various other Algae, including *Spirogyra* and *Vaucheria,* with gratifying results. They are to be further recommended on account of their adaptability to various stains. I have found that the triple stain of Flemming, the Fuchsin-Iodine green of Zimmerman and Ironhaematoxylin all give good results.

Flemming's chromo-osmo-acetic acid mixture was tried for fixing but abandoned owing to the blackening of the tissue

caused apparently by the action of the killing fluid on the chlorophyl and the frequent distortion of the structure of the protoplasm. Solutions containing mercuric chloride were generally unsatisfactory since nearly all details of structure were lost in material killed in them.

The best stain for delicacy of differentiation was Flemming's well known triple stain, although very good results were obtained by the use of Zimmerman's Fuchsin-Iodine green. This brought out the figures of the dividing nuclei very well, but was of little value to aid in studying the pyrenoids and other structures.

I have discussed in another connection (29) the general structure of the cell and have showed that there is no distinct chromatophore in *Hydrodictyon*. In that place I pointed out that the pyrenoids and nuclei were distributed in such a way as to preclude the possibility of the protoplasm between the plasma and the vacuolar membranes being differentiated into distinct layers. We may then pass directly to a consideration of the structure of the cytoplasm and nuclei and the process of cleavage. The cytoplasm varies in appearance from an almost homogeneous finely granular mass with angular vacuoles placed quite wide apart, to a decidedly foamy structure whose typically rounded alveolae differ much in size ranging from very minute, scarcely perceptible openings to quite large vacuoles whose diameter extends nearly the whole depth of the plasma layer. Neither of these appearances is confined to any one stage in the development of the cell. They occur in the recently formed swarm spores as well as in the mature cell, and it is quite probable that they simply represent different conditions of metabolism, etc. The foamy appearance is however much the more frequent of the two in all stages. In many cells having this alveolar structure, there is a tendency for the small alveoli to be arranged in rows giving the appearance of furrows or tubes through the cytoplasm, but in nearly all cases strands or lamellae could be detected cutting off rounded alveoli (Figs. 3, 21). During cleavage there is often a noticeable tendency for the larger vacuoles to be aggregated along the cleavage furrows (Figs. 24–26) in a manner much resembling the arrangement in *Synchitrium*.

Whether the smaller alveoli are really vacuoles in the same sense as the larger openings may be a matter of doubt. But the fact that all grades in size can be found from the very small alveoli to the larger ones would seem to show that there is no difference between them. In many sections the smaller vacuoles appear to be fusing with larger ones. All stages may be made out from that in which the two adjacent vacuoles have nearly their original spherical form to those in which the fusion is almost complete and one appears as a slight protuberance upon the other. The larger vacuoles above described often appear in turn to fuse with the central vacuole so that their membrane becomes continuous with that of the central vacuole (Fig. 2). It is of course possible that the appearance of fusion of the vacuoles just described is due to slight distortion in fixation, for it can be readily seen that if two vacuoles each surrounded by a slight film, are lying very close together; a very slight disturbance in the protoplasm might cause a break in the films so as to give the appearance of stages in the fusion of the vacuoles. Still there seems to be no doubt that in the growth of the cells from swarm spores the central vacuole is the result of the fusion of two or more smaller vacuoles of the young cell.

While the above description of the relations of the larger and smaller vacuoles seems to agree in many respects with what Wilson (35) has recently described for some *Echinoderm* eggs, I have not been able to make out here any such morphological series consisting of granules, microsomes, alveoli and vacuoles as Wilson described. Wherever the alveoli and vacuoles can be made out they seem to be quite distinct from the other cell contents, and I am therefore inclined to think of them as distinct cell organs perhaps in some respects coordinate with such structures as the pyrenoids. Still if this view be correct the question as to the origin of the vacuoles is a perplexing one. The fact that smaller vacuoles may fuse to form larger ones and that as a result of cleavage the large central vacuole entirely disappears, would seem to strongly negative the doctrine of De Vries (31) and Went (34) that the vacuole is a permanent cell organ reproduced by division of a preexisting vacuole. To be sure the vacuolar

membrane is retained as a portion of the plasma membranes of the new cells so that it is in a sense a permanent structure. But it performs an entirely new role and the identity of the vacuole is as completely lost as if the membrane itself were destroyed.

The production of artificial vacuoles by Pfeffer (19) and more lately by Nemec (18) throws little light on the real problem as to the origin of the vacuole, for it is not at all certain that the vacuoles that were apparently formed anew were not already existing, except in those cases described by Pfeffer where the so-called food vacuoles in some of the slime molds may arise as invaginations of the outer plasma membrane. This identity in character of vacuolar and plasma membranes so shown, is important when taken in connection with the fact shown in various Ascomycetes and Phanerogams that the latter membrane is formed by a direct metamorphosis of the kinoplasmic fibres. In various Phanerogamic cells I have shown that the young cell plate splits and the halves become partly separated before the plate has reached the mother cell membrane (27). This fact may furnish a suggestion as to the possible method of origin of vacuoles, for the cleft in the cell plate is essentially a flat vacuole surrounded entirely by the protoplasm of the mother cell, and enclosed by a membrane derived from the spindle fibres. The fact that its membrane finally forms a part of the plasma membrane of either daughter cell may be compared to the history of the membrane of the central vacuole in the cleavage of *Hydrodictyon* and in those fungus sporanges in which the cleavage is partly accomplished by means of numerous small angular vacuoles. To be sure the vacuole formed by the splitting of the cell plate may be considered a very special structure without any relation to the other vacuoles of the cell. But the analogy just pointed out may prove suggestive as to a possible line of investigation in connection with the question of the origin of vacuoles in other cases.

The structure and division of the nuclei of *Hydrodictyon* is in the main features the same as that of the nuclei of the higher plants. In general there are one or more fairly prominent nucleoles that take a bright red color in the triple stain, and a

blue stained chromatin network that can always be clearly seen in good preparations. The nuclear membrane is quite sharply differentiated and sometimes stands out as a deeply stained thick boundary.

While the above general statement is true for all of the nuclei there is a remarkable individual variation both in appearance of contents and in form and size. In a typical resting stage the nuclei are generally quite small spherical bodies with the chromatin arranged in a very fine slightly stained, but very clearly visible network. At various places in the net the chromatin appears to be more or less collected into lumps. Very frequently in cells showing great vegetative activity, as for example, in the growth of the young nets or in cases in which starch is being rapidly formed the nuclei become quite large and vesicular in appearance (See Figs. 41 and 42. Cf. also Fig. 1 in my paper on starch formation in Hydrodictyon). In these cases the chromatin frequently appears as very fine lines radiating from the prominent central nucleole to the periphery. Unless the preparations are well stained the chromatin in such cases might be easily overlooked, but in no stages of cell life have I been unable to demonstrate a clear differentiation of the nuclear contents into chromatin and nucleole.

Spherical nuclei with the contents arranged as above described are always found in cells showing no signs of reproductive activity. In all cases, however, in which cleavage is taking place the chromatin is collected into denser roughly elongated masses taking a deeper stain and connected by fine threads as of linin (Figs. 24–32).

The nucleole becomes much less sharply defined in these than in the resting stages just described and in some cases is so surrounded by the chromatin as to be almost indistinguishable. The whole structure of the nucleus is in fact identical in appearance with the early prophases or late anaphases of division.

The nuclei vary in shape from the spherical forms just described to those with very irregular outlines, some of which are quite sharply angular, while others have blunt rounded extensions resembling the pseudopods of an amoeba. In many cases, especially in cells in process of cleavage, the nuclei are

slightly elongated with one end quite small and drawn out into a blunt point, that is directed toward the cleavage plane (Figs. 29 and 30). In other cases the nuclei are more elongated and the two ends are of the same size. Such forms may be constricted in the equatorial region so as to suggest strongly that direct division is taking place. (Figs. 21a, 22, 23.) Both of the above mentioned forms of nuclei generally occur together in the same cell. (Figs. 21–23). They may in turn be associated with those that are more definitely amoeboid or angular in outline. The size of such nuclei varies very strikingly (Compare Figs. 6, 21, 34 and 44). In figures 6, 34 and 35 are shown the extremely large size that the elongated amoeboid and angular nuclei may reach. Such unusually large nuclei may occur in apparently any stage of cell life, although my preparations have not shown them in ciliated swarm spores. Still they occur in the cells in which the cleavage is complete (Figs. 34, 35), as well as in the cells of very young nets (Fig. 44). By comparing figures 43 and 44 a very good idea may be obtained as to the relative size that such nuclei may attain. Both figures are drawn according to the same scale of magnification.

In all of the irregular shaped nuclei the contents generally present the same appearance as in the other nuclei in the cells in which cleavage is taking place.

The distribution of the nuclei presents some interesting phenomena. Those described above as typical resting nuclei are generally quite evenly distributed throughout the cytoplasm at points equidistant from one another (Fig. 3). The number of such nuclei that may occur in a given area of the protoplasm varies considerably. As Klebs pointed out, cells are often seen in which the nuclei are much too numerous to have swarm spores of the normal size formed in the cell with a single nucleus to each spore. But the assumption that a fusion of nuclei occurs in such cases before or during cleavage is not at all necessary, for there is no evidence that such cells are going into cleavage stages without further growth. Even if they are in the same net in which some of the cells are forming spores they may not, as I shall show later, themselves undergo

such a process, but are just as likely to live for some time vegetatively. The only case in which an excessive number of nuclei need to lead to the assumption of fusion, would be to find such a numerical excess in connection with the *later stages of cleavage,* and this relation I have not found in any of my preparations. It is quite probable that the large number of nuclei is the result of a period of nuclear division just completed that is to be followed by a period of cell growth.

In cells in which cleavage is in progress the nuclei are very frequently arranged in pairs, the two nuclei of a pair often almost touching one another. (Figs. 25–30.) This arrangement is very clearly the result of the process of nuclear division as I shall describe it farther on. Figure 21 shows a very striking arrangement of the smaller irregular nuclei into groups consisting of from two to eight individuals. How such an arrangement came about I have not been able to learn. The forms of the nuclei might suggest that they have moved together from various parts of the cell, but other evidence in support of such a suggestion is entirely lacking. On the other hand it is quite possible that each group represents the product of a series of successive nuclear divisions, and that the individual nuclei will later be distributed more equally throughout the cell. The fact that the dividing nuclei sometimes appear in groups and that the daughter nuclei when first formed are frequently quite irregular in shape, being thus identical in form and structure with some of the grouped nuclei in the conditions shown in Fig. 21, adds weight to this latter hypothesis.

Owing to the small size of the nuclei it is impossible to make out clearly all of the details of karyokinesis, but enough stages stand out sharply to show that the process is essentially the same as in the higher organisms. A very distinct loosely coiled thread is formed that apparently becomes segmented into chromosomes (Figs. 7 and 8). In a few cases I have been able to make out quite clearly that there are ten segments; but usually it was almost impossible to distinguish the individual chromosomes accurately enough to count them. When this stage is reached the nuclear membrane has generally disappeared so that the peripheral parts of the chromosomes lie in im-

mediate contact with the cytoplasm, which has not, however, penetrated to the interior of the nuclear cavity. The nucleole disappears so far as I have been able to observe before the equatorial plate stage is reached.

The history of the spindle in these early stages I have not been able to make out at all. When the equatorial plate stage is reached the spindle is distinct. It usually ends in two sharply defined poles, at either of which there is a small spherical, densely stained body; but there are no indications of polar radiations to form an aster (Fig. 9). The spindle fibres generally come to a sharp point apparently just at the surface of the body so as to give the appearance of a distinct body lying rather in contact with the end of the spindle than forming a part of it.

Owing to the impossibility of observing the early stages of spindle formation the origin of the above described bodies, as well as their relation to spindle development, could not be made out. During the period of the reconstruction of the daughter nuclei when the spindle disappears, the bodies also become indistinguishable. Whether they are the homologues of centrosomes is, in view of the scarcity of data in connection with their history, of course, not evident, still the constancy with which they appear in the equatorial plate stages and early metaphases indicates that they bear the same relation to the process of division as the centrosomes in other cells. I shall apply the name centrosomes to them in the subsequent discussion. In many cases the whole spindle seems to lie in a clear cavity, as if the nuclear membrane persisted throughout the greater part of the division process, but the boundary of this cavity is always quite irregular and I am inclined to think that it is the product of the fusion of the vacuoles of the cytoplasm surrounding the nucleus. (Figs. 9, 11, 12.) In other cases the cytoplasm is apparently in immediate contact with the spindle. (Fig. 10.) The chromatin material in the equatorial plate forms so compact a mass as to render it almost impossible to distinguish the individual chromosomes, and consequently to make out the method of the separation of the daughter chromosomes.

In the metaphases the daughter chromosomes go back to their respective poles in dense groups, all the individuals of each

group lying practically in the same plane. (Fig. 10.) During these stages the spindle is frequently much elongated so that at the beginning of the anaphases the central spindle is drawn out into a fine thread in its middle part. (Fig. 12.) During the anaphases the chromosomes form at first somewhat rounded dense masses that later form the daughter spirems. New nuclear membranes are formed and the daughter nuclei are completely organized. While the formation of the daughter nuclei is taking place they undergo a remarkable change of position. With the disappearance of the central spindle the nuclei approach each other so that by the end of the anaphases they lie almost in contact. (Figs. 12–14.) The explanation of this change in position is not at all evident. I have described a similar phenomenon in connection with the formation of the cell plate in the onion and larch and suggested that it might be due to the mechanical pressure of the cytoplasm upon the daughter nuclei which pushes them into the space left vacant when the central spindle disappears. The same explanation may possibly hold here although the small number of fibres constituting the central spindle would seem to render it less probable. The juxtaposition of the daughter nuclei thus brought about gives a striking appearance to the cells where all of the nuclei are frequently in pairs. This position of the nuclei, as previously stated, may persist in the cleavage stages. Fig. 20 presents a curious condition in which it appears as if the chromosomes, instead of going back to the poles in compact bodies, as above described, are here more or less strung out along the spindle fibres either singly or in irregular clumps. The explanation of these figures is not apparent. It is possibly due to some peculiar effect of the fixing fluid although the other cell contents show no abnormalities.

Interesting variations in the size and form of the spindle are shown in figures 17–19. In figures 18 and 19 is shown very clearly that two spindles lying closely adjacent to one another may vary as much in size as do the nuclei in some cases in which division is not clearly in progress. That the apparent difference in size is not due to a possibly somewhat flattened spindle viewed in different aspects is shown in polar views of the equa-

torial plates in which the chromatin mass always appears, so far as my preparations show, to be nearly equal in its length and breadth. The equatorial plate in the larger spindle consists of a greater amount of chromatin than that of the smaller one. Whether the number of chromosomes varies in the two cases is an important point that I could not determine, as I was unable to find the stages of division in which the chromosomes could be distinguished from each other. It is quite probable that the different sized nuclear figures are derived from nuclei that differed in the same respect before division commenced, though I have not yet succeeded in finding the stages that would confirm this suggestion. The largest spindles are somewhat multipolar with the chromatin arranged in such a way as to form a branched equitorial plate (Figs. 17a and 19a), so that the entire figure has the appearance of the well known cases of polycentric nuclear figures in cells treated with certain poisons or subjected to other unusual stimuli. But there was no other evidence of abnormality either in the structure of the cytoplasm or that of the nuclear figures themselves.

So far as I could determine there was no particular time during the day when nuclear division was most likely to take place. Material in which I have found it was in part killed at various hours during the forenoon and in part in the afternoon. In a small amount of material killed at different times during one night, I was unable to find any indications of division, but of course so small an amount of material would not show conclusively that it never takes place at night. Still it seems quite evident that there is no regular daily period to which division is confined. This is made the more certain by the fact that in a single net one cell alone may show nuclear division while in the other cells the nuclei seem to be in a resting condition. That, however, the divison depends upon conditions common to the whole cell is shown by all of the nuclei of a single cell dividing at the same time though without being in the same stage. Very often all stages from the early prophases to the late anaphases can be found in a single cell in a more or less regular succession from one end of the cell to the other. (Figs. 15 and 16.) This fact is in-

teresting when taken in connection with the fact that in the process of cleavage the same order of events is frequently observed.

As is known, any cell of a net may form spores without the accompanying cells being visibly affected. It generally happens, however, that a number of the cells are in some stage of spore formation at the same time. I have frequently found in my material single nets of which the majority of the cells were in a vegetative condition while one might show stages of cleavage, another ciliated spores, and in still another there would be a newly formed net. The relation of these different cells to another so far as their position in the net is concerned, I could not make out, since in imbedded and sectioned material the general arrangement is difficult to determine. I have not made any special observations as to the age of the nets whose cells produce swarm spores, although such an investigation would be of great value. Klebs has shown that a number of special conditions of nutrition, etc., will cause spore formation, but the age of the cells thus experimented upon was not accurately determined.

The first indication of the approach of cleavage consists of the disappearance of the pyrenoid and increase in thickness of the protoplasm. This latter phenomenon is very clearly shown in Fig. 32, which shows sections of two adjacent cells, in one of which cleavage has just begun, while in the other there is no indication of it. In the account of the process of starch formation in *Hydrodictyon* I described the disappearance of the starch and pyrenoids as usually occurring before cleavage begins, but showed that such a process is not necessarily preliminary to cleavage since it sometimes happens that some of the starch and the pyrenoids may persist through all the stages even to the spores and young cells formed from them.

Cleavage itself is, as Klebs pointed out, a progressive process; but it is accomplished entirely by means of two sets of surface constrictions instead of, as Klebs thought, by means of intraplasmic vacuoles. In the first stages in the process short furrows that have no apparent special orientation with reference to one another or to the nuclei appear here and there through

the cytoplasm. (Fig. 22.) Seen in a surface section these furrows appear as single lines and thus might easily be taken for cell plates formed in the protoplasm without the help of visible spindle fibres; but if a vertical section is studied, the appearance of furrows becomes manifest. (Figs. 31–32.)

In these latter sections it is also clearly shown that the cleavage furrows thus formed cut through at right angles to the surface. In none of my material have I found the furrows forming appreciable oblique angles with the surface, although such a phenomenon might of course occur in large cells in which the protoplasmic layer is much thicker, as for example, in such a cell as that shown in Fig. 2. I have not succeeded in getting the stages of cleavage in these larger cells. During the succeeding stages the furrows become branched and increase in length so as to soon intersect with one another and thus block out very irregular multinucleate areas on the surface of the protoplasm. Concurrently with the development of the cleavage furrows on the outer surface similar ones are formed by the vacuolar membrane on the inner side of the protoplasm (Fig. 33.) The two furrows from opposite sides finally meet in the interior of the protoplasm and fuse, thereby completely cutting through the entire layer. The process of growth and branching of the cleavage furrows continues until the entire protoplast is cut into uninucleate pieces, which later round up into the swarmspores.

While the two sets of cleavage furrows generally seem to accomplish the complete division by coming together from opposite places on the two surfaces, it frequently happens that one furrow may reach nearly through the entire layer of protoplasm before there is any indication of a corresponding furrow being formed on the opposite side. Still I have not found any cases where one furrow cut clear through without meeting a constriction from the opposite side. The deeper constriction may, however, be from either the inner or outer surface. In the early stages of cleavage the constrictions are irregular and wavy in a surface section, while in the later stages they seem to become straighter and their intersections form sharper angles. (Fig. 27.)

As before stated the process of cleavage may show a succession of stages from one end of a cell to another. Figures 26, 27, and 28 bring this out very clearly, since they are all taken from the same cell at different regions thmrough its length. The process of cleavage above described seems to go on in its early stages at least, entirely independently of the nuclei, but the result is always, with an exception to be presently noted, the formation of uninucleate segments. In cells in which the cleavage planes cut between recently divided nuclei, so that the nuclei lie quite close to the cleft, the nuclei frequently have the elongated pointed shape previously described. (Figs. 28, 30.) The smaller end of the nucleus lies nearest the cleavage plane. In some cases a distinct granule can be seen lying next to the newly formed membrane at the point nearest the smaller end of the nucleus. Whether this granule has anv special significance could not be determined. Its occurrence is by no means constant, and the cases where it was observed are quite possibly accidental ones, the granule itself being but one of the numerous small bodies frequently found in other parts of the cytoplasm as well.

When the cleavage has reached the uninucleate stage the segments begin to separate from one another and to round up into distinct bodies. The sides of the cleavage furrows are drawn away from each other so as to leave between them irregular quite broad clefts through the protoplasm. (Fig. 30.) So far as I have observed the clefts do not usually appear until the uninucleate stage is reached, but in some cases the separation may take place before cleavage is complete with the result that large binucleate masses form spores directly. In these spores there is a pair of cilia connected with each nucleus. (Fig. 39.) These giant spores were, as previously stated, observed by Braun and his conclusion that they represent cases of incomplete cleavage is undoubtedly correct. The clefts thus produced are perhaps what Klebs thought were intraplasmic vacuoles, and it is quite possible that he failed to see the earlier stages showing the cleavage furrows first formed. It would certainly be very easy to overlook such stages in material poorly fixed and stained and viewed only from the surface of the entire cell.

An explanation of the mechanics of the process of cleavage described above is by no means obvious. The best known cases of cell formation from large coenocytic cells in plant tissues are those of the formation of a layer of endosperm cells from a large multinucleate mother cell and those cases of spore formation in certain fungus sporanges as described recently by Harper. · The *Hydrodictyon* cell has a striking superficial resemblance to the multinucleate endosperm mother cell in that in both cases there is a relatively thin layer of protoplasm containing numerous nuclei and surrounding a large central vacuole. There is also somewhat of a resemblance in the process of cleavage in that a somewhat regular succession of stages may be observed in passing from one end of the cell to the other. (See Strasburger, 23.) But at this point the resemblance ceases, and it may serve to bring out more sharply the problem to be solved in case of *Hydrodictyon* if the differences in the actual process of cleavage in the two cases are pointed out. In the first place in the embryo sac the cleavage is very clearly in direct connection with the nuclei the position of any one part of the cleavage plane being determined jointly by the two nuclei that are connected by the fibres in which that part of the cell plate is being formed. To be sure the planes may not always be so arranged as to cut out uninucleate pieces as Strasburger has shown for *Corydalis* and other forms, but in these cases it is none the less true that where the division does take place the cleavage plane is just as distinctly determined by the nuclei in pairs. In *Hydrodictyon* as previously shown, no such relation of cleavage planes to nuclei is at all evident, with the possible exception of those cases where the constriction cuts in between two recently formed nuclei. Again, in the embryo sac the process is clearly initiated and practically completed in the midst of the protoplasm, the two boundary membranes being simply divided into portions that form the outer and inner portions of the membranes of the new cells, the lateral membranes being formed entirely anew from the spindle fibres, while in *Hydrodictyon* the process is clearly indicated on either surface by the limiting membranes and its completion depends

upon their further growth from the surface inward, so that the new cells are entirely surrounded by the portions of the two original membranes. The cleavage in the two cases, then, so far as the mechanics of the process is concerned seems to belong to totally different categories. Still if the previous suggestion that the cleft formed by the splitting of the cell plate is comparable to a vacuole prove correct it would become more nearly possible to find a similarity in the two processes, but even in that case it must be kept clear that the substance for the increase in extent of the vacuole in the one case is furnished by the spindle fibres for whose formation the nucleus is probably a metabolic center while in the other there is not the slightest direct evidence of any such connection between the nucleus and the growth of the membrane forming the cleavage furrow. To be sure there may be, as Harper has suggested for *Synchitrium,* a diffusion of kinoplasmic material from the nucleus to the plasma membrane, but here, as in *Synchitrium* direct evidence for such diffusion is entirely wanting. On the whole the process of cleavage in *Hydrodictyon* seems to correspond most closely to that of the fungus sporanges in which there is a progressive and complete cleavage, as for example in the formation of the protospores in *Synchitrium decipiens* and *Pilobolus* where the cleavage continues to the ultimate formation of the uninucleate cells.

A point of much significance in connection with the cleavage in *Hydrodictyon* is the fact that the two membranes which take part in the cleavage are entirely discontinuous, although they lie parallel to each other with a relatively thin layer of protoplasm between them. But the two cleavage furrows produced by these independent membranes from opposite sides regularly meet in the midst of the protoplasm. This would seem to render necessary the assumption that the impulse for division is seated in the protoplasm between the two membranes rather than in the membranes themselves. Such an assumption need not involve the conception that the beginning of the process takes place in the protoplasm between, but merely that the stimulus to which the cleavage is a response is an internal stimulus acting upon the two membranes at

the same time, a conception that, however, in no way helps to a mechanical explanation of the process. The conditions here must be kept sharply distinct from those cases of the bipartition of a single coenocytic cell by simple constriction, as for example cell division in *Cladophora*. In this latter case one may readily imagine that the stimulus arises in the membrane itself and is either external or internal since it is a case of the construction of a single continuous membrane.

When the spores are fully formed it is quite evident that they are entirely separated from one another. It is not improbable that what Klebs took for connecting strands of protoplasm was the slime which is sometimes found on the inside of the central vacuole lying next to the vacuolar membrane.

The general structure and form of the spores I have found to be identical with that described by previous observers. The young spores are generally almost spherical bodies with the nucleus occupying a position near the plasma membrane and connected with a pair of cilia which are attached to the cell at the point nearest the nucleus. (Fig. 36.) In older stages the portion to which the cilia are attached becomes somewhat elongated and filled with hyaline protoplasm, that extends down into the cell as far as the nucleus. (Figs. 37 and 38.) In connection with the structure of the swarm spore most interest now attaches to the locomotor apparatus. This consists in all of the normal uninucleate spores of a pair of cilia attached to a small spherical basal body lying generally in contact with, but quite clearly independent of the plasma membrane. (Fig. 38.) Connecting the basal body with the nucleus there are two or more protoplasmic fibres. Owing to the small size of the above mentioned organs, it is extremely difficult to make out any details as to their structure or origin. The basal body generally stains quite densely, especially in the triple stain. In the best stained preparations it frequently appears to be of a dark red color, a fact that shows quite clearly that it is entirely distinct from the plasma membrane, which, in the same preparations has a blue color. In nearly all cases too it can be seen that the contour of the basal body is clearly distinct from the plasma mem-

brane. (Fig. 38.) It is not impossible that the basal body is the granule previously described, that lies against the cleavage furrow near the nucleus in the latest stages of cleavage; but I could not find such a body during the stages of separation and rounding up of the spores.

The threads connecting the basal body with the nucleus are very fine and are not always easy to distinguish from the surrounding cytoplasm; but in most cases they are clearly enough differentiated to enable one to trace them from one body to the other. They are colored in the various staining methods used about the same way as the spindle fibres or cilia, and in general appearance resemble very much such structures. There is no evidence, however, that any portion of the spindle ever remains after nuclear division is complete which could be identified as these threads. At the point where a connecting thread is in contact with the nucleus there is no indication of any distinct body or even a swelling of the nuclear membrane. I have sometimes found three such threads quite plainly visible, but in most spores there are only two. I have found no cases in which it was clearly evident that there was but a single thread.

The cilia appear as single fine threads resembling in staining capacity and structures the spindle fibres. In spores in which the contour of the basal body is clearly distinct from the plasma membrane, the attachment of the cilia to the basal body itself can be clearly seen. (Fig. 38.) The points of attachment of the two cilia to the basal body may either lie at some distance from each other or they may be in immediate contact. (Figs. 36–39.) As previously indicated, the protoplasm in the forward end of the spore has in the mature spore a hyaline homogeneous appearance. This fact makes the differentiation of the basal body and connecting threads much clearer than it otherwise would be. In the giant swarmspores there is a complete locomotor apparatus consisting of cilia, basal body and connecting threads connected with each nucleus. (Fig. 39.)

As is well known, the swarmspores of *Hydrodictyon* do not normally escape from the cell wall within which they are formed but after swimming about for some time in the cavity

come to rest, lose their cilia, become surrounded by cellulose walls, and become attached to one another at various points so as to form a young net that is later set free by the breaking down of the mother cell wall. The changes that occur in the cell contents during growth are of importance as throwing some light upon the structures found in mature cells. In the very young cells I have looked carefully for the first indications of the formation of the pyrenoids but without getting much light as to the nature of the process. As Braun long ago showed, these organs are formed shortly after the spores come to rest. The youngest stages in which I could clearly distinguish structures that were undoubted pyrenoids showed them as small spherical red stained bodies enclosed by a hyaline region sharply bounded off from the surrounding cytoplasm (Figs. 41 and 42). The difficulty of identifying the earliest stages in the formation of such structure lies in the fact that any of the numerous granules so frequently found in the cell may be mistaken for a young pyrenoid, and I have not discovered any reaction by which to determine whether such bodies are or are not the young pyrenoids. It is interesting, however, in this connection, to note that the pyrenoids and nuclei are generally quite closely associated in the young cells, and that in many cases the number of nuclei is the same as that of the pyrenoids. But this equality is lost in the older stages and the number of nuclei is frequently in excess of the number of pyrenoids. The reverse condition, however, is often observed. See especially Fig. 44, where the number of pyrenoids is greatly in excess of the number of nuclei, a relation that holds quite generally in the case of these very large nuclei.

I did not find any stages of the first nuclear division, but a comparison of Figs. 40 and 41 shows clearly that a large increase in the size of the cell may occur before any nuclear divisions take place. (See also Fig. 43.) It is important to note, however, that the increase in size of the cell is out of proportion to the increase in the amount of protoplasm. Before a cell has grown very much, fairly large vacuoles begin to appear in either end apparently leaving a very thin layer of

protoplasm between themselves and the cell wall (Fig. 41). The nucleus and pyrenoid are generally situated in the central region of the cell where the protoplasm still extends between the vacuoles clear through the diameter of the cell, as is clearly shown in a cross section (Fig. 42). In these early stages in living cells, the chlorophyl can only be seen in the thicker portions of protoplasm as the middle part in which the nucleus and pyrenoid lie and the ends where the vacuoles do not press out to the cell wall. But this appearance is probably due to the fact that the layer of cytoplasm between the cell and vacuoles is so very thin as to render the color indiscernible when viewed from the surface. There is certainly no indication in sections of any differentiation of the cytoplasm to form a chromatophore in this or any other stage of the cell life. The arrangement described above is undoubtedly what led to Artari's (2) statement that in the earlier stages the chromatophore is a branched structure similar to the chromatophore of *Draparnaldia*. But if Artari had had better prepared material he would have seen that there is no trace of any differentiation of the protoplasm into an organized chromatophore.

As the cell becomes larger the vacuoles fuse into one large central vacuole and the protoplasm, now containing numerous nuclei and pyrenoids, becomes evenly distributed in a layer next to the cell wall (Fig. 1).

If we attempt now to apply the facts described in the foregoing pages to the problems suggested in the introduction, several points of general interest are at once apparent. Notwithstanding the very small size of the nuclei the structure and essential features of mitotic divisions are identical with those of the higher plants. *Hydrodictyon* agrees in this respect with all of the carefully investigated cases of nuclear structure and division in the other thallophytes with the possible exception of *Spirogyra*, in which it seems quite probable according to the recent researches of Mitzkewitsch and Wisenlingh that the nuclear structure is different from that of most other forms. But in that case the peculiar structure of the nucleus probably represents a highly specialized type and

is not to be considered in any way more primitive than the ordinary type of nucleus found in other thallophytes and the higher plants. The existence of a body so closely resembling a centrosome in *Hydrodictyon* is in accord with the facts as worked out in other lower forms, especially among the Fungi and brown Algae.

The significance of the variation in size of the nuclei is not at all clear. The very large nuclei probably represent cases of unusual growth of the smaller ones. Such a variation in size of the nuclei is not uncommon in other plants at different stages of the life history. For example, in the uninucleate plant of *Synchitrium* the nucleus is many times as large as the nuclei of the multinucleate stage or the single nuclei of the spores. The striking fact in *Hydrodictyon* is, however, that the very large nuclei may occur in practically any stage in the life history. Whether these large nuclei give rise to smaller ones by division, as is the case in *Synchitrium,* is not clearly evident; but the variation in the size of the spindle indicates that they do.

The question as to whether direct nuclear division takes place in *Hydrodictyon* is as yet unsettled. While many of the figures indicate quite strongly stages in such division, the evidence is not at all conclusive. As Hertwig very justly remarks, the mere fact that a nucleus may be elongated and constricted in its equatorial region is not to be taken as positive evidence that direct division is in progress, for in many cells the nuclei are capable of assuming a great variety of forms without showing any other indication of division. In *Hydrodictyon* the capacity of the nuclei to assume such variations in form is very marked and it is quite probable that the elongated nuclei that appear to be constricted in the middle are simply forms of resting nuclei coordinate with the more angular or pointed forms.

As the facts at present stand, there are two distinct methods of cell division in plant cells, peculiar to the thallophytes on the one hand, and the cormophytes on the other. In the former types we have such coenocytic cells as the fungus sporanges and the *Hydrodictyon* cell where there is a progressive

cleavage by means of surface constrictions. In cell division in *Cladophora,* conidia formation in the mildews, and the cutting off of the gametes in *Sporodinia* we have simple constriction, as Harper has pointed out. All of these cases may be grouped together as examples of cell division by constriction and thereby be clearly distinguished from the case of the cormophytes where cell division is accomplished by means of the formation of a cell plate.

These two types of cell division are most sharply differentiated when compared as to their relation to the nuclei. In the case of division by constriction there is no visible relation of the nuclei to the process so far as the mechanism involved is concerned, while in the case of cell plate formation the nuclei are apparently the active controlling centers for the process by means of the spindle fibres, many of which, and sometimes all, may be formed for the express purpose of cell division.

The relation of the processes of cell division in certain brown Algae to the two types above described is not at all clear. In all of these forms so far described division is said to take place by means of a cell plate that is formed without being directly connected with the nuclei. (See 9, 17, 24, 26.) Owing to the difficulty of getting numerous stages of division in these forms it is quite possible that some of the most important phases have been missed.

The structure of the swarm spore of *Hydrodictyon* compared to the structure of other ciliated cells presents many interesting problems. The most thoroughly investigated cases of the development of such cells is that of the spermatozoa of the higher animals and the antherozoids of some Pteridophytes and Gymnosperms. While there are some differences as to detail, zoologists seem to be in accord as to the main facts concerning the development of the spermatozoon (See, Wilson, 36.) The axial filament of the tail grows out from a spermatid centrosome that may persist as a distinct body ("end knob") at the base of the fibre or may enlarge to form a part of the middle piece. This fact of the growth of the axial filament from the centrosome forms a possible basis of comparison be-

tween the spermatozoon and the swarmspore. The cilia of the swarmspore clearly bear the same relation to the basal body as does the axial filament to the middle piece or more particularly to that part of the middle piece derived from a centrosome. But whether the basal body really corresponds to the middle piece must be left unsettled until its origin is determined.

Discussion of the question as to whether the basal body in *Hydrodictyon* corresponds to the blepharoplast of some Pteridophytes and Gymnosperms, is for the present quite premature. That question is also quite distinct from the further one as to the homology of the blepharoplast itself.

The development of the swarm spores in such forms as *Cladophora* and *Oedogonium* needs to be carefully investigated. Strasburger's (24) conclusion that the individual nodule at the base of each cilium is merely a swelling of the plasma membrane was based entirely, so far as his descriptions and figures indicate, upon the study of the fully formed spores. It is quite possible that early stages in the development of the spores would show that the origin of both the cilia and the nodules at their bases is quite different from what Strasburger supposed it to be.

University of Wisconsin, November, 1901.

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PLATE XXIX.

EXPLANATION OF PLATE XXIX.

All figures were drawn with the aid of the Abbe camera lucida and with the Zeiss apochromatic objective 2 mm. aperture 1.30, and compensating oculars 2, 4, 12, and 18. They have been reduced in reproduction to 7/10 the size of the original drawings.

Fig. 1, Vertical longitudinal section of an entire cell, x 175.

Fig. 2, Small portion of section similar to that shown in Fig. 1, showing distribution and structure of cell contents, x 600.

Fig. 3, Portion of tangential section, x 1500.

Fig. 4, Portion of tangential section, showing large spherical nuclei, x 1500.

Fig. 5, Procleavage stage, after disappearance of pyrenoids, x 1500.

Fig. 6, Vegetative stage with large nuclei, irregular in outline, x 1500.

Figs. 7–14, Successive stages of nuclear division, x 2250.

Figs. 15–16, Different parts of a single cell, showing successive stages of nuclear division from one end of the cell to the other, x 600.

Figs. 17–19, Spindles of unequal size, a. Multipolar spindles, x 1500.

Fig. 20, Unusual forms of figures of nuclear division, x 1500.

Fig. 21, Irregular forms of nuclei, collected into groups, x 1500.

Figs. 22–23, Early cleavage stages. Many nuclei with elongated or pointed shapes, x 1500.

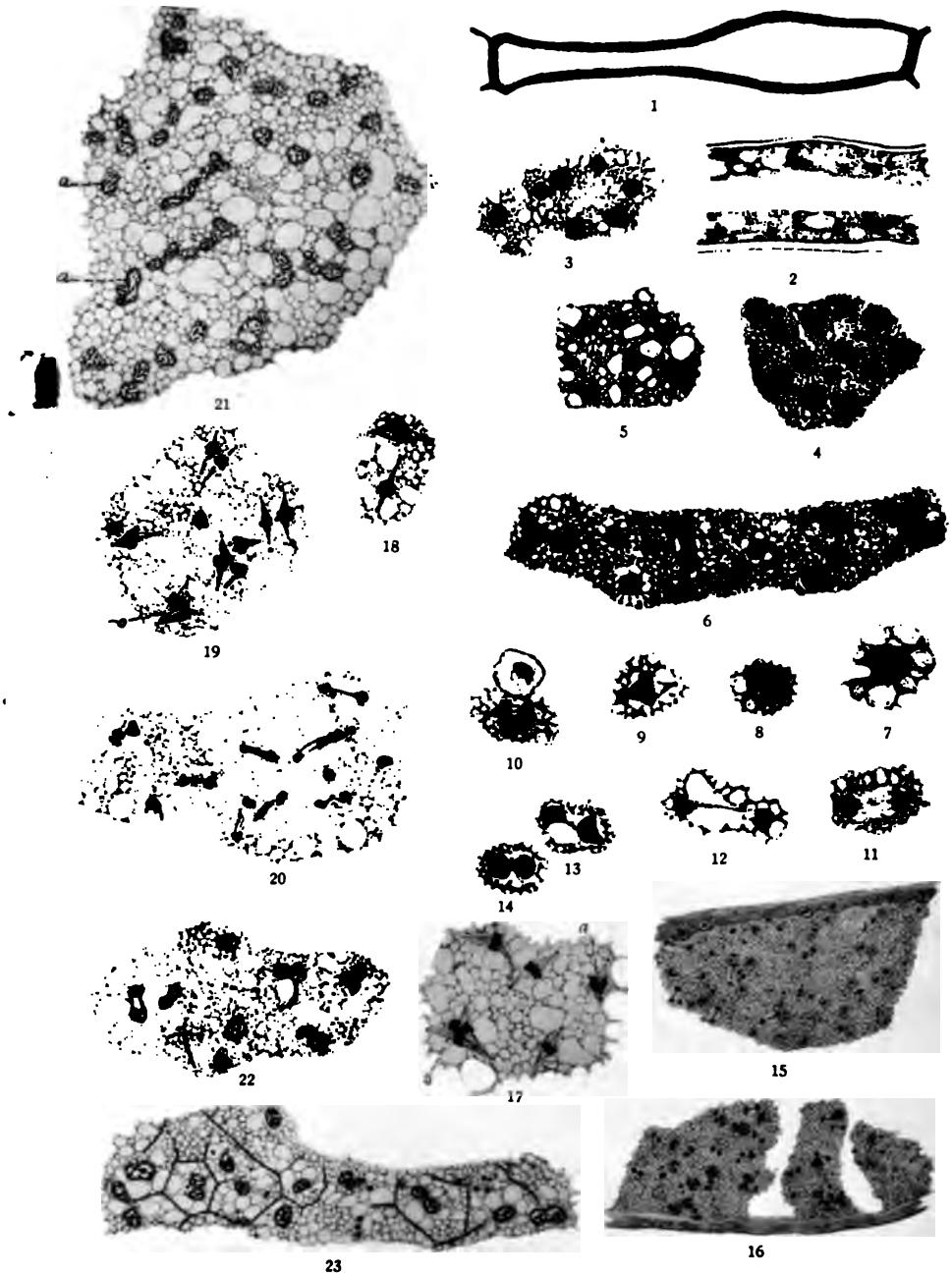
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PLATE XXX.

EXPLANATION OF PLATE XXX.

Figs. 24–25, Successive stages of cleavage, x 1500.

Figs. 26–28, Successive stages of cleavage as found in different parts of the same cell, x 1500.

Fig. 29, Late stage of cleavage. Nuclei arranged in pairs with cleavage planes cutting in between the adjacent nuclei, x 1500.

Fig. 30, Beginning of the separation of the uninucleate segments, x 1500.

Fig. 31, Cross section of cell in early stage of cleavage with the cleavage furrows formed by both plasma and vacuolar membranes, x 600.

Fig. 32, Portion of vertical section of two adjacent cells, one of which is undergoing cleavage, x 1500.

Fig. 33, Portion of vertical longitudinal section of cell in late cleavage stage, x 1500.

Figs. 34–35, Uninucleate segments containing large irregular nuclei, x 1500.

Fig. 36, Young swarm spores with cilia, x 1500.

Fig. 37, Mature swarm spores, x 1500.

Fig. 38, Anterior end of mature swarm spore, showing locomotor apparatus, x about 3000.

Fig. 39, Giant swarm spores. Mostly binucleate, x 1500.

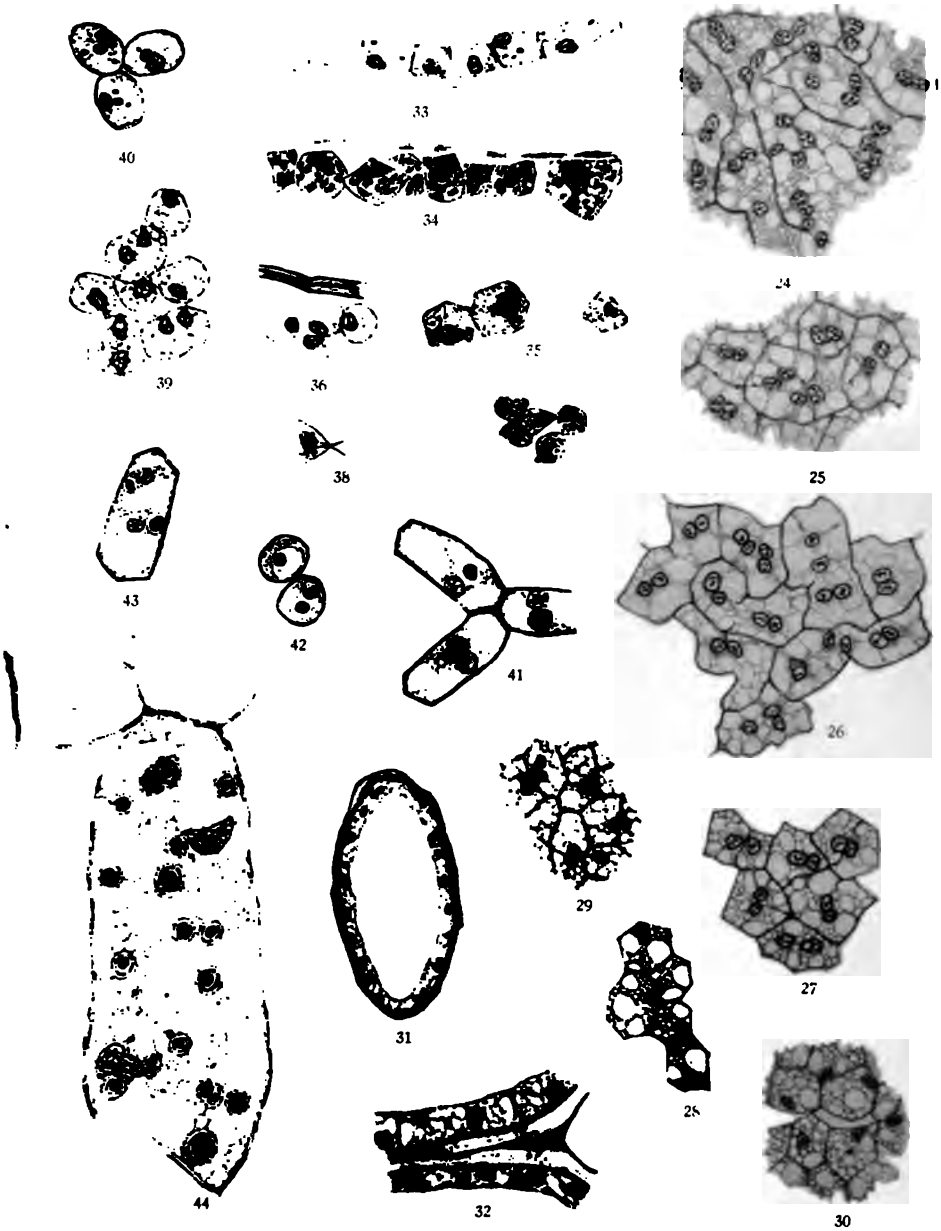
Fig. 40, Longitudinal sections of cells of very young net, x 1500.

Fig. 41, Longitudinal sections of somewhat older cells. Each cell still contains a single nucleus and a single pyrenoid, x 1500.

Fig. 42, Cross sections of cells in same net as those in Fig. 41, x 1500.

Fig. 43, Binucleate stage of young cell, x 1500.

Fig. 44, Section of a quite large cell containing but two large nuclei, x 1500.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AXIAL BIFURCATION IN SNAKES.

ROSWELL HILL JOHNSON.

This paper contains descriptions and skiagraphs of thirteen two-headed snakes, a recapitulation of others previously described, and a concluding general treatment of this abnormality.

In the belief that the skeleton should be the basis of descriptions of cases of axial bifurcation, I have studied as many of these abnormalities as could be obtained from American museums. It seemed to me that skiagraphy, offering an opportunity for such skeletal study, might reveal some possible laws of this abnormality. The numerical data for the thirteen individuals is given in Tables I and II.

Case I. This is the case recorded as "a small double-headed snake from South America," No. 856, in the descriptive Catalogue of the Anatomical Museum of the Boston Society for Medical Improvement. This museum is now a part of that of the Harvard Medical School. This specimen [Plate XXXII, Fig. 1] was found to have scales impermeable to Roetgen rays, the only one of the snakes in which this was the case. The snake is in so bad a condition as to render specific determination difficult. It is probably *Tropidonotus fasciata fasciata* Linn., the range of which is the Austroriparian Region, or the Southern States. A normal specimen of this species, however showed the scales to be permeable to the Roentgen rays. The arrangement of the shields upon the dorsal aspect of the head is unusually irregular as Plate XXXIII, Figure 1a, shows. The angle of the sagittal planes of the skulls is 90°, that of the frontal planes is about 145° with the angle facing dorsally. Measurements upon the two divisions show that the left is less than a millimeter shorter and slightly broader than the right division.

TABLE I.

Skulls united.

	LEFT SKULL.		RIGHT SKULL.		CONDYLE TO TAIL.
	Length.	Length to Union.	Length.	Length to Union.	Length.
1	10	7	10	7	170
2	13	7	13	7	250
11	8	3	8	3	123

Skulls separate.

	Length Left Skull.	Length Right Skull.	Length Left Neck.	Number of Vertebrae.	Length Right Neck.	Number of Vertebrae.	Length Remaining.
3	14	14	5	9	5	10	215
4	11	11	21	26	19	25	225
5	9	9	3	10	4	6+	162
6	14	13	9	11	7	8	289
7	11	11	11	18	11	16	251
8	9	9	17	22	18	22	190
9	13	13	16	22	17	20	210
10	14	14	72	67	85	72	245
12	10	9	15	25	11	20	119
13	9	9	3	6 ap.	3	6 ap	165
14	10	11	2	9	3	10	151

Case II. This is a *Bascanium constrictor* Linn. [Plate XXXII, Figs. 2 and 2a, Plate XXXIII, Figs. 2b and 2c], from the collection of the Buffalo Society of Natural Sciences. It was without label but was undoubtedly brought in from the vicinity of Buffalo, where the species is occasionally seen. The point of division of the heads of this snake is close behind the eyes. Plate XXXIII, Figs. 2b and 2c, show the arrangement of the plates on the heads. The angle of the sagittal planes is 75°. The two frontal planes coincide. Here also the left head is slightly shorter and broader than the right.

TABLE II.

CASE.	DATA IN TERMS OF MAXIMAL LENGTHS OF VERTEBRAE.			DATA IN TERMS OF PROPORTIONAL LENGTH.		
	Left Division.	Right Division.	Remainder.	Left Division.	Right Division.	Average.
1	7	7	170	3.8	3.8	3.8
2	6	6	208	2.7	2.7	2.7
3	14	14	153	8.1	8.1	8 1
4	29	27	205	12.5	11.8	12.1
5	12	13	162	6.9	7.4	7.1
6	18	15	222	7.4	6.5	6.9
7	20	20	228	7.8	8.1	7 9
8	26	27	190	12.0	12 4	12.2
9	29	30	210	12.1	12.5	12.3
10	57	66	163	27.8	28.8	28.3
11	4	4	166	2.3	2.3	2.3
12	30	24	143	17.4	14.4	15.9
13	13	13	181	6.8	6 9	6.8
14	11	13	151	2 4	3.7	3.0

Case III. This is an *Ancistrodon piscivorus* Lacépède [Plate XXXIV, Fig. 3], lent from the collection in the Washington and Jefferson University. The heads are equal in size and normal in appearance except that there is an additional supralabial upon the right side of the right head. The angle of the sagittal planes is 105°, that of the frontal planes about 150°, facing ventrally.

Case IV. This *Ophibolus getulus getulus* Linn. [Plate XXXIV, Figs. 4 and 4a], is No. 7276 in the Smithsonian collection. It was found by Miss Marshall at Point Tobacco, Maryland, and was described in the American Naturalist, Vol. XII, p. 470, by H. C. Yarrow. The heads are equal. The angle of the frontal planes is a trifle less than 90°. The vertebral column of the right division is in less intimate connection with the common vertebral column than that of the left division.

Case V. This specimen [Plate XXXV, Fig. 5], lent through the kindness of Mr. Whiteaves by the Geological Survey of Canada, bears this label: "Shore of Moira Lake, near Modoc, Aug.

1886. E. Coote." It is a *Eutainia sirtalis sirtalis* Linn. The light dorsal stripe divides caudad to the point of division of the vertebral column. The angle presented by the frontal planes of the two heads is nearly a right angle, that of the sagittal planes is about 70°. The right head is slightly longer and broader than the left one.

Case VI. This *Pityophis catenifer* Blainv. [Plate XXXV, Fig. 6] lent by the California Academy of Sciences was collected by J. W. A. Wright in 1878. It was later described in the American Naturalist, Vol. XII, p. 264. The angle presented by the frontal planes of the two heads is about 115°, that between the sagittal planes about 35°. A ventral fold of skin which extends forward from the point of division in the plane of the gastrosteges is present similar to that in the Ophibolus, No. 7276 of the Smithsonian collection.

Case VII. This is another *Ophibolus getulus* Linn. [Plate XXXVI, Figs. 7 and 7a] lent by the Smithsonian Institute. It was collected by J. M. Spainhorer in Lenoir, N. C., and bears the number 14540. The frontal planes make an angle of about 90°. Their longitudinal axes are almost parallel, however, for the necks curve toward the plane of the common partition and are connected by skin for an unusual distance cephalad. The heads are equal.

Case VIII. This is a *Thamnophis elegans lineolata* Cope [Plate XXXVI, Fig. 8] belonging to the University of California. The data given are "Marin Co. (?) California. 1879. C. A. Allen, collector." An additional peculiarity in this snake is the presence of a sharp angle in the common vertebral column, as shown in the skiagraph. The light dorsal stripe, prominent in this specimen, divides sharply 5 mm. cephalad to this angle and so is considerably caudad to the external division as well as to the vertebral division. There are twenty-one longitudinal rows of scales, which is the normal number for this species, from the sharp angle to a point about two centimeters caudad to it, where two rows end. Cephalad from where the dorsal stripe divides, many new rows begin. The right neck is shorter and the right head slightly shorter and narrower than the left.

Case IX. This is the young *Bascanium constrictor* Linn. [Plate XXXVI, Fig. 9] described by Wyman in 1863. It was obtained from the Warren Museum of the Harvard Medical College. When the necks are as long as in this specimen, it is impossible to determine the angle of the frontal planes. However, as the snake is now, this angle is 90°. The heads and necks are nearly equal. From the point of external division to the point of division of the vertebral column, the dorsal blotches are in two rows.

Case X. This is the snake in the United States National Museum bearing the catalogue number 25398 [Plate XXXVII, Figs. 10 and 10a.] It was collected by Miss M. Desha; the locality is not given. It belongs to the genus *Pityophis,* but its specific position in this difficult genus is less plain. If, however, the species *Pityphis sayi* Schlegel be made to include *Pityophis bellona* Bd. and Gird, following Cope, it may be called *Pityophis sayi,* since it seems intermediate between these two forms. This specimen is remarkable for the extreme length of the anterior doubled portion, which is much longer than in any case ever described, with the exception of that of Redi. The skiagraph reveals the division of the vertebral column very much farther back than that of the bodies proper, although the color markings show irregularities over the portion underlaid by the two vertebral columns.

Case XI. This small snake embryo [Plate XXXVIII, Fig. 11] has been so bady dessicated that a determination of its species is impossible. Together with cases XII and XIII it was purchased from a dealer, Mr. N. L. Wilson of 170 Tremont St., Boston, Mass., who was unable to furnish data concerning any of his specimens. The point of division is posterior to the eyes. The angle of the sagittal planes is approximately 80°, and there is no appreciable angle of the frontal planes.

Case XII. This is an embryo of *Eutainia sirtalis* Linn, still without color [Plate XXXVIII, Fig. 12.] It is remarkable for the considerable inequality in the length of the two necks and the deficiencies in structure. The right head on the shorter neck is singularly deficient. The lower jaw is represented by a mere stump and the dorso-ventral thickness of the

head is much reduced. The eyes are absent on this right head, but two slits possibly representing orbits are found lateral to the parietal plates. The left side of the lower jaw of the left head is also deficient.

Case XIII. This is either an embryonic or very young *Tropidonotus fasciata sipedon* Linn. [Plate XXXVIII, Fig. 13]. The inner side of the left head is deficient, there being no eye. A sharp angle is noticeable in the vertebral column resembling very much that of Case VIII. Somewhat farther caudad is a loop with the ventral surfaces inward and mutually coalesced. Cephalad to this loop is a median deficiency in the gastrosteges making an opening into the abdominal cavity. The number of longitudinal rows of scales is variable, for rows begin and end at several points along the body. The angle of the frontal planes is about 90°.

It might be well at this point to put on record other cases of two-headed snakes which were described in the popular press or which were seen by the author but were not made the subject of detailed study.

Mr. Outram Bangs had a young *Tropidonotus fasciata sipedon* Linn. which he had collected at Stoneham, Mass. In degree of bifurcation it resembled the individual described above as Case II.

In the Scientific American of December 5, 1896, is an article describing a double-headed snake and illustrated by a cut from a photograph. It is said to be a *Heterodon simus* Linn. from Central America. But since this locality is outside the range of the species as given by Cope, it is probably wrong. From the cut the degree of bifurcation seems to approximate that of Case VI. in this paper.

A two-headed snake was advertised on exhibition in a cigar store in New York in 1896 or 1897. The owner, Mr. H. C. Somers, told me that after the snake died, it had been destroyed. It was found in the Catskills, though attributed in an advertisement to South America. I believe that this was the snake described in the Scientific American.

A two-headed snake was found near the New York Zoological Park in 1901. The New York Tribune said it was a

milk snake ten inches long. Judging from the photograph reproduced in the paper, the degree of bifurcation was most nearly like that in Case XII.

Dr. J. S. Kingsley in describing an abnormal frog in the American Naturalist, Vol. XII, pp. 694–695, states that a two-headed snake is in the collection of the Lyceum of Natural History at Williams College. Prof. S. F. Clark informs me, however, that the snake probably referred to is one which merely simulates this condition from having been crushed.

Mr. Samuel Garman tells me that this abnormality may be found frequently in embryoes of *Tropidonotus fasciata sipedon* Linn.

RESUME OF ALL CASES DESCRIBED.

Table III records the more important data gathered from previous descriptions of two-headed snakes which are sufficiently complete.

TABLE III.

Author. Date.	Species.	Degree of Bifurcation.	Angle.	Relative size of divisions.
Aldrovandi. 1640.....	(From Bologne)	From the cut the common body was 32 cm. long. The right division was 5 and the left division 4 cm. long.		Left division 1 cm. longer.
Redi. 1684.....		Divisions about 22 per cent. of whole length. Spinal cord double to middle of back. Two œsophagi, lungs, stomachs, hearts, and livers. One intestine and set of genital organs.		Equal. The right heart and right lung larger.
Lacépède. 1789.... ..	"Perhaps Vipère Fer de-Lance." *Lachesis lanceolatus* Lacép.	One neck with two heads.	50°+	Equal.
Edwards. 1751	"Yellow snake of Barbadoes."	Union just anterior to corners of mouth but mouths separate. 10 cm. to point of union. 26.5 cm. total length.	19°ap. Frontal planes at acute angle.	Equal.
Edwards. 1751.	"Common English snake."	Two heads quite separate. Necks unite about an inch from the heads.		
Bancroft. 1769.	"Probably *Tropidonotus fasciata sipedon* Linn." Garman. Lake Champlain.	Point of union behind cephalic shields but necks very short.	90°ap.	
Mitchill. 1823..	*Bascanium constrictor* Linn.	Necks very short.	Frontal planes at right angle.	The distance to tip of left head is 3 mm. less than to tip of right head.

Mitchill. 1826.	*Bascanium constrictor* Linn. Same brood.	Heads separate at eyes. Three eyes.		Equal.
Mitchill. 1826.....	*Bascanium constrictor* Linn. Same brood.	Three eyes. Single lower jaw. Heads separate at corner of mouth. Body single only 13 mm. of its length. 94 cm. to tip of right tail. 110 cm. to tip of left tail.		Left anterior part of the head larger. Left tail 16 cm. longer.
Wyman. 1863.....	*Tropidonotus fasciata sipedon* Linn.	Each head supported by a distinct neck. The tail also double for about an inch. At middle of body size is increased and vertebral column is double and provided with a double set of ribs.		Equal.
Dusseau. 1865.....	*Tropidonotus natrix* Linn.	Two distinct necks.	Acute angle.	
Dorner. 1873.	*Pelias berus* Merr.	Each head on its own short neck. Two hearts. Two lungs wholly separate. Vertebral columns united 16 mm. from the tip, or 10 3 per cent. of total length of 155 mm.		Left head a mere trifle larger. Right heart larger and behind left heart.
Boettger. 1890.	*Pelamis bicolor* Band.	Four nasal plates instead of two. Four nasal openings.		Equal.
Von Braun....	*Tropidonotus natrix* Linn. Embryo 15 mm. long.	The point of division lies in the region of medulla.	130°	Equal.
Borgert. 1897.....	*Pelias berus* Merr.	See case XIV in other tables.	60°	Right division slightly longer.

Species. One must expect more of these abnormalities to be found in those species native to regions where most attention is paid to the fauna and also in the most abundant species. Yet after making these corrections, it is probable that this axial bifurcation is more frequent in some species than in others.

Tabulating the data, we find:

Tropidonotus.
- 3 *T. fasciata sipedon* Linn.
- 2 *T. natrix* Linn.
- 1 *T. fasciata fasciata* Linn.

5 *Bascanium constrictor* Linn.

3 *Eutainia.*
- 2 *E. sirtalis* Linn.
- 1 *E. elegans lineolata* Cope.

2 *Ophibolus getulus* Linn.

2 *Pelias berus* Merr.

2 *Pityophis.*
- 1 *P. catenifer* Blainv.
- 1 *P. sayi* Schlegel.

1 *Ancistrodon piscivorus* Lacépède.

1 *Pelamis bicolor.*

1 *Lachesis lanceolatus* (?)

1 *Heterodon simus* Linn (?)

1 "Yellow snake of Barbadoes."

This result together with Mr. Garman's statement concerning *Tropidonotus* would seem to make it advisable to examine gravid snakes of the genus *Tropidonotus* and eggs of *Bascanium* if in search of this abnormality.

Type of Bifurcation. The great majority of cases are those of cephalic bifurcation, the catadidyma of Fisher. None show merely caudal bifurcation, the anadidyma of Fisher. But three cases have been described where both cephalic and caudal bifurcation existed, the anacatadidyma of Fisher. These are the case of Wyman and two of the three described by Mitchill. The former's specimen is further remarkable for a median duplicity of the vertebral column,

which is the only case of the kind on record and which lies without Fisher's system of classification.

Degree of Bifurcation. The data as regards degree of bifurcation aside from the thirteen cases here described and that of Borgert have little quantitative value, for frequently the descriptions are no more specific than merely "two-headed." Fortunately, however, the fact is sometimes noted whether there are two heads on separate necks, or two skulls in organic fusion. Classifying on this basis we have:

8 dipropi:
  7 near the eye.
  1 in the region of the nose.
23 dicephali:
  15 "short neck."
  8 "long neck."

In Tables I and II, and Plate XXXI, the degrees of bifurcation of the thirteen snakes here described and the one of Borgert (No. 14) are represented. Only by such precise criteria can the question of degree of bifurcation be properly studied. Three criteria were employed as a discontinuity might be shown by one criterion which would not be shown by the others. These were the number of vertebrae, the lengths of the divisions in terms of proportion of the total length and in terms of vertebral units. The lengths of the divisions were measured to the cephalic end of the skeletal division, not the external division. The vertebral unit was chosen, i. e., the length of one vertebra where the vertebræ are largest, because it was found that occasionally in the divisions there was a very large number of abnormally small vertebræ. In each case, both classification by the longer division and by the average division was used.

Even the few cases here described are so discontinuous in their distribution as to degree that I believe it is safe to say that axial bifurcation is more likely to occur in some degrees than in others, and that the most frequent degree is from about 6 to 13% of the length from the cephalic end.

Angle of Bifurcation. In the case of dicephali, the general rule may be made that when the vertebral column is double for a very short distance, the angle of divergence of the proximal

ends of the double vertebral column is a large one, and it decreases as the degree of bifurcation increases. This applies only to the bifurcation of the vertebral column. The apparent angle made by the divisions does not seem to conform to any rule.

In the cases of dipropi the rule is the reverse,—the greater the degree of bifurcation, the greater the angle.

The frontal planes of the two heads do not always coincide, but may meet at an angle. In all the cases of dicephali, this angle was directed downward. Of the three cases of dipropi, the angle was directed upward in one, and in the other two there was no appreciable angle.

Accompanying Abnormalities. In the cases of dicephali, the necks are likely to be of different lengths, the difference being greater as the necks are longer, though with the data in hand, it cannot be said that the difference would be greater in comparison.

Abnormalities of the shields on the head are not noticeable in the cases of dicephali, except where there is marked deficiency, but they are evident in the cases of dipropi, as would be expected. These irregularities, however, were usually of proportion and of outline, rarely of absence or of redundancy.

Deficiencies were noted in three cases: VIII, XII, and XIII, enough to lead one to believe that they are frequently correlated with axial bifurcation. Another peculiarity which seems to be correlated in some way is the presence of sharp angles in the vertebral column in Cases VIII and XIII.

Especial attention has been given in this paper to the point of divergence of the vertebral column. This, however, does not fully express the degree of bifurcation of the color markings and of the internal organs. I think it may be said that when the color markings show a longitudinal arrangement, they will be affected caudad to the point of division in the axis.

Data concerning the internal anatomy of these anomalies are very uncommon, the only instances of adequate descriptions being those of Redi, Dorner, and Borgert. The evidence there given certainly shows that in these cases there was a doubling of internal organs caudad to the vertebral bifurcation.

SUMMARY AND CONCLUSION.

1. Thirteen two-headed snakes are described by means of skiagraphs.

2. The previous descriptions of two-headed snakes are reviewed.

3. It is concluded that this abnormality is more abundant in some species than in others and that the point of bifurcation is most likely to occur in the cephalic half of the snake, between 6 and 13% of the entire length from the cephalic end.

4. The point of bifurcation of the vertebrae is more posterior than would be supposed from external examination. The skulls frequently appear united externally when in reality they are not.

I am much indebted to Prof. C. B. Davenport for kind advice and assistance, to Mr. Samuel Garman for help in determination of species, to Mr. Outram Bangs, Mr. F. K. Mixer, Mr. J. F. Whiteaves, Prof. Edwin Linton, Mr. F. W. True and to Prof. W. E. Ritter for loans of material, and to Dr. W. McM. Woodworth for assistance with the bibliography and for the loan of books.

Anatomical Laboratory, University of Wisconsin,
November 21, 1901.

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PLATES XXXI–XXXVIII.

EXPLANATION OF PLATES.

The figure numbers in each plate correspond to the number of the case.

The skiagraphs were taken with dorsal surfaces next the plate. The sides are not reversed therefore in the figures, as may be seen by comparing the photograph and skiagraph in Plate XXXVII.

Figures 12 and 13 are tracings from skiagraphs since the plate was broken before good prints were obtained.

Figure 11 is a drawing substituted by the engraver for an obscure skiagraph.

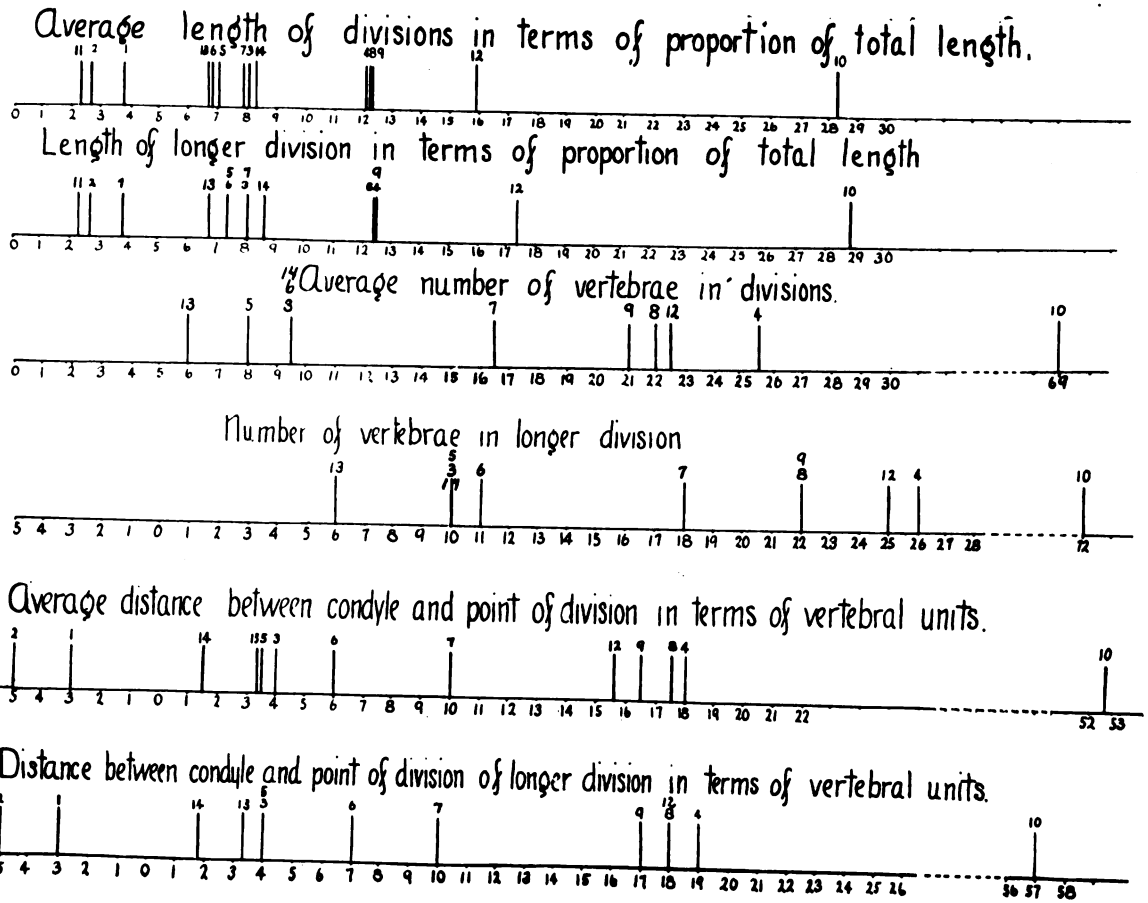

Average length of divisions in terms of proportion of total length.
Length of longer division in terms of proportion of total length
% Average number of vertebrae in divisions.
Number of vertebrae in longer division
Average distance between condyle and point of division in terms of vertebral units.
Distance between condyle and point of division of longer division in terms of vertebral units.

FIG. 1

FIG. 2

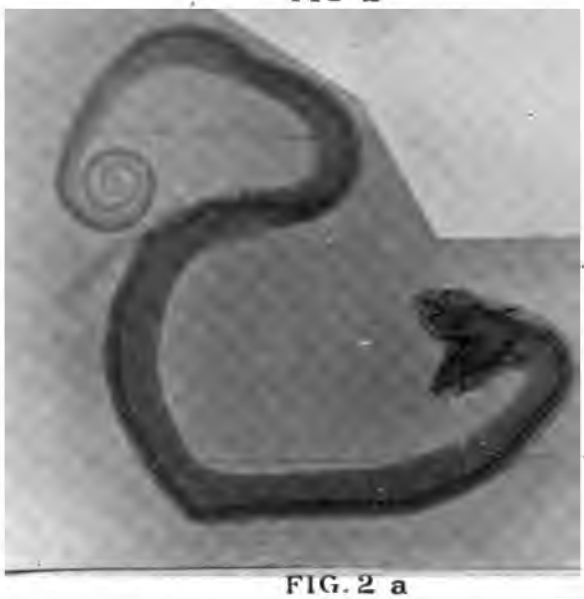


FIG. 2 a

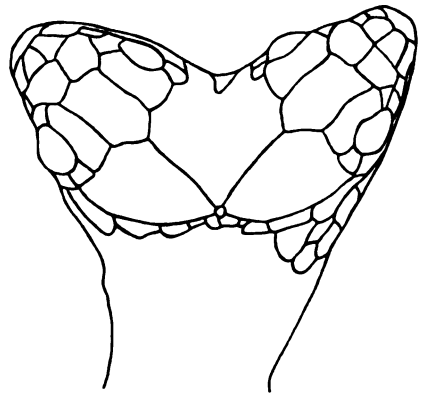


FIG. 1a.

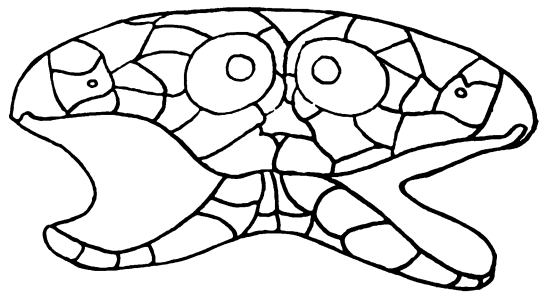


FIG. 2b.

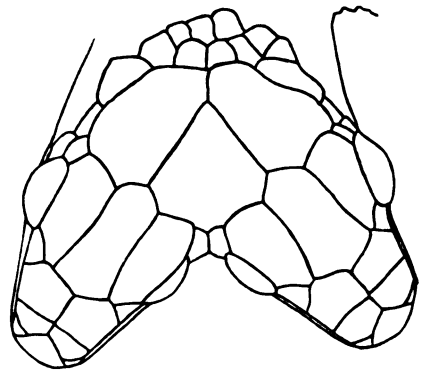


FIG. 2c.

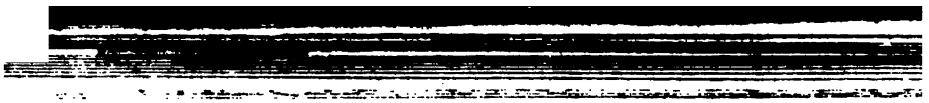


FIG. 3

FIG. 4

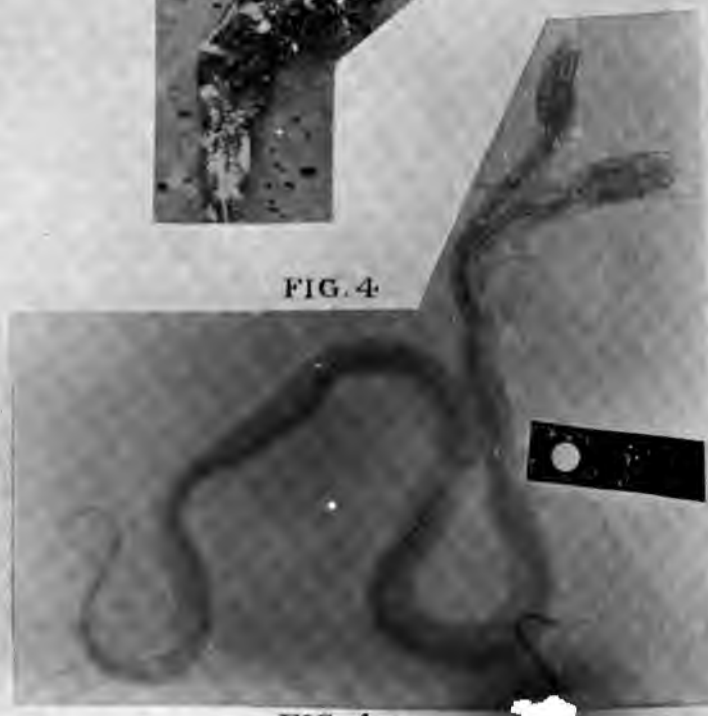


FIG. 4 a

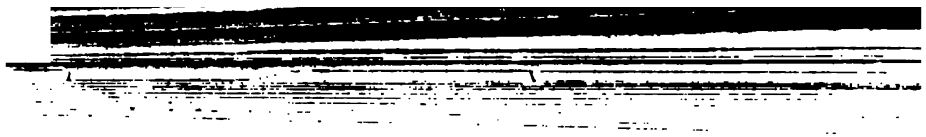
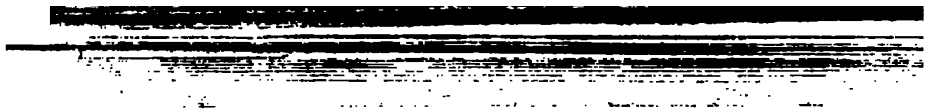


FIG. 5

FIG. 6



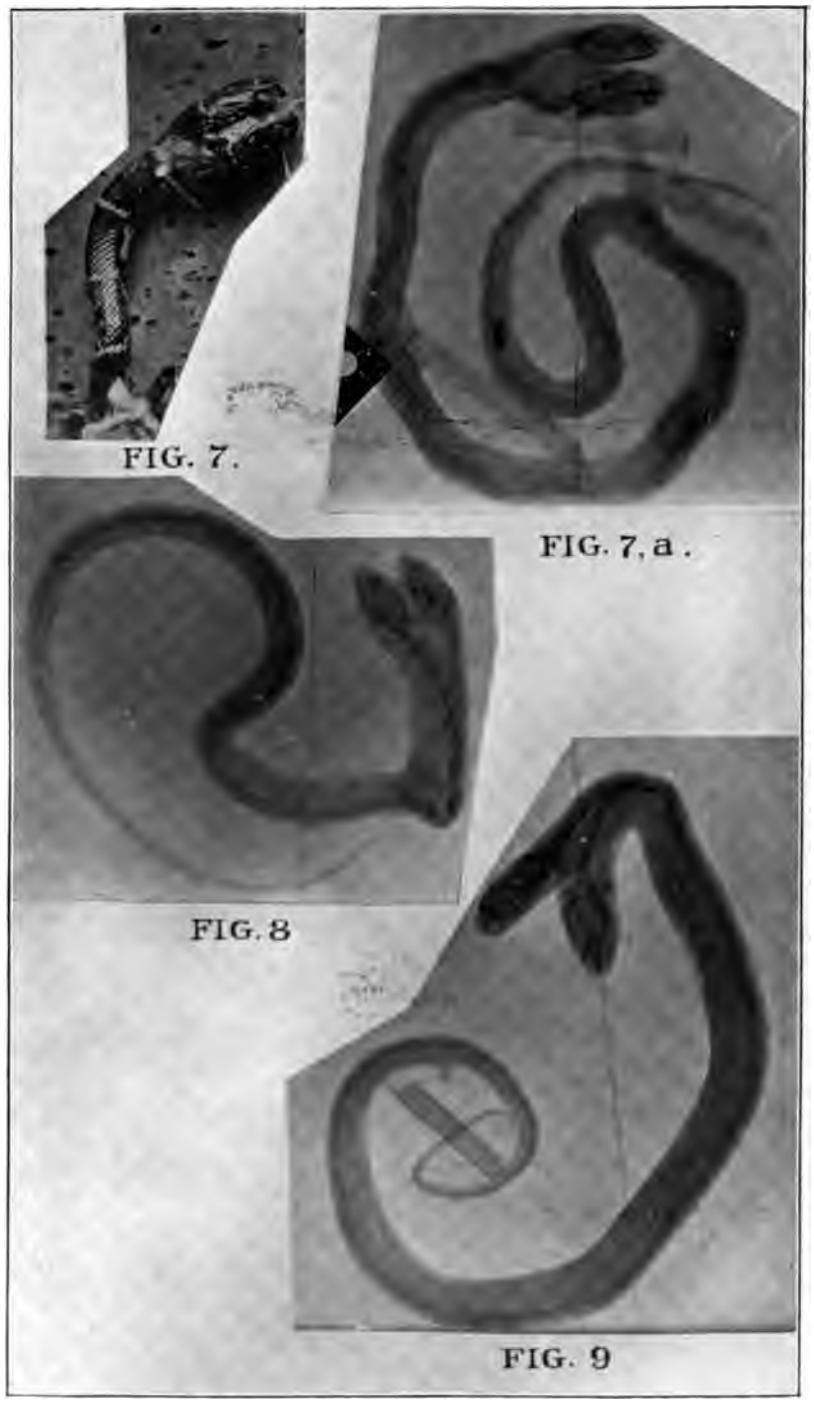


FIG. 7.

FIG. 7, a.

FIG. 8

FIG. 9

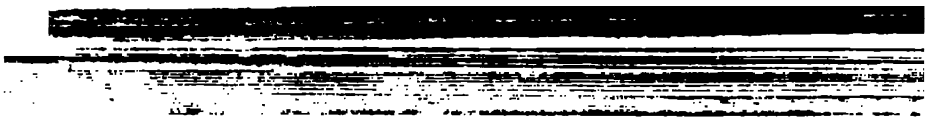


FIG. 10.

FIG. 10 a.

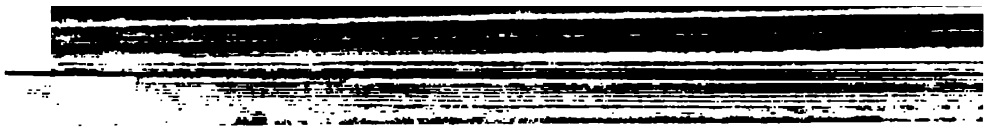


FIG. 11

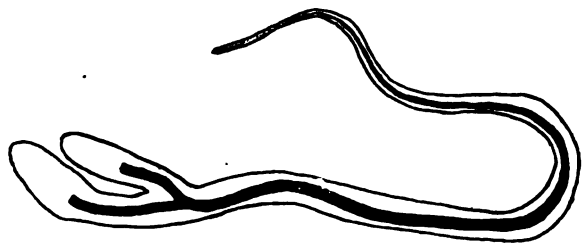


FIG. 12

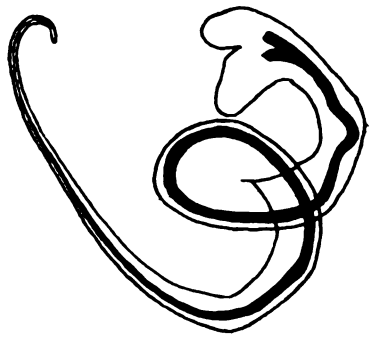


FIG. 13

ON THE RELATION BETWEEN HEAT CONDUCTIVITY AND DENSITY IN SOME OF THE COMMON WOODS.

LOUIS W. AUSTIN AND C. W. EASTMAN.

In 1828 De la Rive and De Candolle,[1] after examining the conductivities of five varieties of woods, announced the interesting fact that along the fibers the thermal conductivities of the different woods were approximately proportional to their densities. Some observations made by C. G. Stangel[2] in 1899 in connection with his work on the effect of moisture on the heat conductivities of woods and rocks called attention again to the relations between the conductivities and densities of woods. As far as has been ascertained no other work has been done on the subject since that of De La Rive and De Candolle, the extensive work of Tyndall[3] on woods being confined to the rapidity of propagation of the heat wave, or, diffusivity.

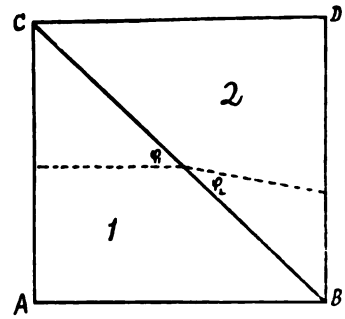
In our own experimental work a method was made use of which was presented in outline by Voigt[4] in 1898, the general plan of which is as follows: The specimens whose heat conductivities are to be compared are cut in the form of right angled triangles and joined along the hypotenuse, as shown in the figure. If one of the edges AB be heated until a steady flow of heat is established so that the temperature at each point becomes constant, the isothermal lines in the lower specimen will be parallel to the base AB, while in the upper specimen they will be bent upward or downward depending on whether the conductivity is greater or less than in the lower. Accord-

[1] De la Rive and De Candolle, Pogg. Ann., vol. 14, 1828, p. 590.
[2] C. G. Stangel, University of Wisconsin Thesis, 1899.
[3] Tyndall, Phil. Trans. Roy. Soc., vol. 143, 1853, p. 217.
[4] Voigt, Wied. Ann., vol. 64, 1898, p. 95.

ing to the tangential law of refraction of a disturbance crossing the boundary of two media in which it is propagated with conductivities k_1 and k_2,

$$\frac{K_1}{K_2} = \frac{\tan.\ \varphi_1}{\tan.\ \varphi_2}.$$

The determination of the relative conductivities then resolves itself into the measurement of the angles ϕ_1 and ϕ_2. In practice the isothermal line is determined by the melting of a thin layer of wax spread over the specimen.



In applying this method to determining the relative conductivities of woods the following arrangement was used: Blocks of wood about 8 cm. square and 2 cm. thick were cut in triangular form and placed in a wooden frame with their fibers parallel to AC, as shown in the figure. These were covered on the bottom and on the sides AC and BD with thick pieces of asbestos to cut down the loss of heat. A uniform distribution of heat along AB was obtained by pressing a strip of iron of about the same dimensions as the edge of the block against the wood, and heating this by means of a row of small gas flames. The wax used to show the isothermal line was composed of paraffin mixed with a little turpentine. This mixture had a melting point of about 40° and gave a sharp line of demarcation between the melted and unmelted portions. To prevent the wax soaking into the wood and also to insure a more uniform radiation both blocks were covered with a sheet of tinfoil on which the melted wax was painted with a flat brush. This de-

vice was first used by C. G. Stangel in his work on heat conductivity to which reference has already been made.

It was found that there were two chief sources of error to be guarded against, the first of which is the direct effect on the wax of radiation from the source of heat. To prevent this the metal from which heat is communicated to the wood must not be allowed to extend above the edge of the wood, this being much more effective than any system of screens used with a larger heating plate. The second possible source of error lies in the difficulty in obtaining a perfectly good contact between the specimens. To insure this as far as possible, two strips of tinfoil were placed between and the blocks pressed tightly together by means of wedges. It was also found necessary in order to preserve the contact, to plane the blocks frequently as they became warped by the heat. With these precautions very uniform results were obtained.

In our experiments only the conductivities parallel to the fibers were tested. The piece next to the source of heat (position 1 in the figure) was in all cases the same specimen of white oak, the others being placed in position for comparison with it. The densities were determined partly by weighing and measuring the specimens and partly by the method of immersion. Five sets of angles were taken for each wood and the average of these used in computing the conductivity. These measurements were estimated to be correct to within two per cent. Some errors are undoubtedly introduced into the results by the fact that in the second specimen the flow of heat is not in general strictly parallel to the fibers, and since the conductivity at right angles to the fibers is smaller, the true values of the conductivities of some of the lighter woods may be slightly greater than those given. In order to reduce the relative conductivities at least approximately to absolute units, the value for walnut parallel to the fibers, found by Péclet[1] is assumed to be correct for our specimen and the conductivities of all the other woods are expressed in the same terms.

[1] C. G. S. System of Units, Everett, p. 128.

In the following table are given the conductivities and densities of the twelve woods examined:

Wood.	Density.	Cond'ctivity.	Wood.	Density.	Cond'ctivity.
Sequoia.....	0.380	0.000342	Gum	0.559	0.000458
Butternut.....	0.394	372	Walnut.....	0.609	480
Pine.....	0.406	358	White oak.	0.615	472
Linden	0.408	391	Brown ash.....	0.649	539
White wood.....	0.506	426	Georgia pine.....	0.657	540
Cherry.....	0.534	451	Red birch..... ..	0.711	528

The results of the work seem to indicate that the law of proportionality between heat conductivity and density, as announced by De la Rive and De Candolle is at least very approximately obeyed. It is true that in our results slight exceptions to this are shown but it is quite possible that all the variations observed are due to errors of observation. It seems more probable, however, that slight variations really do exist, as the difference in form of the cells in different woods must produce a difference in the distribution of material which would in itself, at least in some degree, affect the conductivity.

The University of Wisconsin, December, 1900.

ECONOMIC AND SOCIAL DEVELOPMENT OF KENOSHA AND LA FAYETTE COUNTIES.

ROBERT HUGH DOWNES, B. L., AND KATHERINE PATRICIA REGAN, B. L., WITH AN INTRODUCTION BY ORIN GRANT LIBBY, PH. D.

INTRODUCTION.

The two studies in local history following this introduction are part of a year's seminary work on a new field in Wisconsin history. The purpose of this seminary has been to lay an adequate statistical foundation for later work of a somewhat different character. Owing to the fact that accurate and detailed state records are not published to any considerable extent by any state it became necessary to compile carefully a large body of statistics from the original records before any really valuable research work could be carried on in Wisconsin local history. In the two senior theses published under this cover the complete record, on which a part of the discussion is based, are to be found in the appendix. Smaller tables in more concise form and maps of several kinds appear in the papers and make clear what is sought to be proved.

The work so far accomplished has proceeded along certain definite lines. A special county has been studied, not as a whole but with reference to its units, the towns. The boundary changes have been in most cases worked out and there has been a brief survey of the geological condition and the main topographical features in so far as they bear upon the question of soil and general productive power. Following this the distribution of the population is studied, and the nativity of the whole population is worked out for every town. This supplies a basis for a still further study of the per capita wealth, occupation, etc., of all who have entered the state since 1850. Thus

in this way we are able to compare the productive power of the various nationalities, to discover where they go and what occupations they engage in. To some degree also we may be able to trace the movement of emigration across the continent by the birth places of the various members of a family who in the end settle in this state. In one of the theses the study was carried to the political conditions and the various nationalities were considered not only as immigrants and producers of wealth, but also as voters. One not unimportant result of the study so far as carried on, is the means it has afforded for the correction or verification of the published census records of the state and United States. The count of the actual population for 1850, 1860 and 1870 has enabled the students to discover substantial errors in the published reports.

It is my purpose in the end to use this work of the seminary for a series of years as the foundation and starting point for an economic history of Wisconsin. The great problems of immigration, of industrial change and development, and of the influence of foreigners on our social, economic and political life can never be fairly discussed without some such careful study as is indicated above. It is no slight task to undertake the examination and arrangement of the hitherto unpublished records of the state. But the task has been attempted with the hope that the results obtained will be of permanent value to the student of statistics and political economy, as well as to the student of sociology and of history.

I desire to acknowledge my indebtedness to the Secretary of State for his courtesy in loaning to the State Historical Society, at my request, the copies of the original United States census returns for 1850, 1860 and 1870, on file in his office. This rendered these very valuable unpublished materials more accessible to the students of my seminary for the present year and made the labor of compiling statistical tables less burdensome. These census reports seem to have been entirely ignored heretofore by students of Wisconsin history and it is to be hoped that they will not again be lost sight of by students of local history in the state.

O. G. Libby.

University of Wisconsin, November 28, 1901.

ECONOMIC AND SOCIAL DEVELOPMENT OF KENOSHA COUNTY.[1]

ROBERT HUGH DOWNES.

CHAPTER I.

FORMATION OF THE COUNTY AND TOWNS.

Kenosha county is located in the southeastern part of the state of Wisconsin. It is bounded on the east by Lake Michigan and on the south by the state of Illinois, and covers an area of 268.04 sq. miles. At the territorial formation of the present state of Wisconsin in 1836, the state was divided into four counties—Crawford, Iowa, Brown, and Milwaukee. The region north of the parallel 46° 31′ north latitude was yet unorganized. The southeastern part of the state was included in Milwaukee county.[2] An act passed by the legislative assembly in 1836, provided that the townships number one, two, three, and four north, of ranges nineteen, twenty, twenty-one, twenty-two, and twenty-three east of the fourth principal meridian be erected into a separate county, named Racine.

By this act what is now Kenosha county was included in Racine county and it remained a part of Racine county until 1850, when by an act approved January 30, 1850, it was enacted that all of Racine county within the boundaries, commencing at the southwest corner of township one, range nineteen east and running thence east on the state line to the center of lake Michigan; thence northerly along the eastern boundary line of Wisconsin to the township line between townships two and three; thence west on said township line to the range line between ranges

[1] A thesis submitted to the faculty of the University of Wisconsin for the degree B. L., June, 1901.

[2] Formation of the counties of Wisconsin. A thesis by Herbert Scott Blake, '94, pages 3–4, 5, 21–22.

nineteen and twenty east; thence south on said range line to the section line between sections twenty-four and twenty-five, in township two, range nineteen east; thence west on said section line to the range line between ranges eighteen and nineteen east; thence south on said range line to the place of beginning, shall be erected into a separate county called Kenosha.[1]

The boundary of the county as determined by the above act has never been altered, but since that time there have been several changes in the town boundaries for no special reason other than local advantage or convenience. The accompanying maps, I and II, show Kenosha county and the towns as erected by the act approved Jan. 30, 1850, and as they are today. By consulting these maps one will readily see the nature of the changes that have been made. The legislature, Jan. 2, 1838, created the towns of Salem, Pleasant Prairie, and Southport.[2] Salem and Pleasant Prairie have remained unchanged to the present time, while Southport by an act of the Board of Supervisors of Kenosha county, Feb. 26, 1853, was vacated and divided. The parts, except so much of the town as was embraced in the city of Kenosha by the act of the legislature of Jan., 1850, incorporating the city, were added to the towns of Somers and Pleasant Prairie. That part of Southport lying in town one north, range twenty-three east, was annexed to the town of Pleasant Prairie, and that part lying in town two north, range twenty-three east, was annexed to the town of Somers.[3] The towns of Bristol and Paris were created by the action of the County Board of Supervisors of Racine county, Jan. 11, 1850, and neither have been changed since that time. It was impossible to ascertain the dates when the towns of Brighton, Pike, and Wheatland were created, but all three existed when Kenosha was formed. Brighton has remained unchanged, while the name of Pike was changed to Somers early in 1851.[4] The town of Wheatland was divided by the action of the Board of Supervisors of Kenosha county in 1860 by a line commencing at the

[1] Session Laws, Wis., 1850, p. 25. Southport Telegraph, Friday, Feb. 15, 1850.
[2] Hist. of Racine and Kenosha Counties, 1879, p. 308.
[3] Alterations of Towns, filed March 9, 1853. File Town Plats, "Old", Office of Sec. of State.
[4] Kenosha Telegraph, April 11, 1851, March 21, 1851.

northeast corner of section thirteen, town one, range nineteen east, and extending west on the north line of sections thirteen, fourteen, fifteen, sixteen, seventeen, and eighteen to the range line, and the town of Randall created.[1] This was the last change made in the boundaries of any of the towns.[2]

Chapter II.

GEOLOGY, SOILS AND TOPOGRAPHY.

The surface features of the county are simple and undulating in character with a gentle slope to the southeastward. The height of the land above the level of Lake Michigan gradually increases, with the exception of a small region in the western part of the town of Pleasant Prairie and the eastern part of the town of Bristol, to the westward, reaching its greatest height in the extreme northwestern part of the town of Wheatland.

The important rivers in the county are the Fox, Des Plaines, and the Pike. These are located in the western, central, and northeastern parts of the county, respectively. The current in these rivers and their tributaries is not swift enough to furnish any power for manufacturing purposes.[3] The slight rise in the height of the land in the eastern part of the county which extends through the central part of the town of Pleasant Prairie, and then northwestward through the towns of Somers and Paris is notable because it makes the streams which flow into Lake Michigan short and abrupt, and forms a continuation of the watershed between the St. Lawrence and the Mississippi basins.

In its geological formation Kenosha county is divided into four distinct north and south sections by the deposit of four different varieties of coarse drift by the glaciers upon the Niagara limestone, which forms the bed of the entire county. These four different varieties of drift differ from each other

[1] Kenosha County Records.
[2] For changes in town boundaries see Plate XXXIX.
[3] Census taker of 1850, remarked: "The only remarkable thing to be seen in this town (Bristol) is a flouring mill built upon a stream (Des Plaines) that it would require an 'observation' to tell which way the water runs."

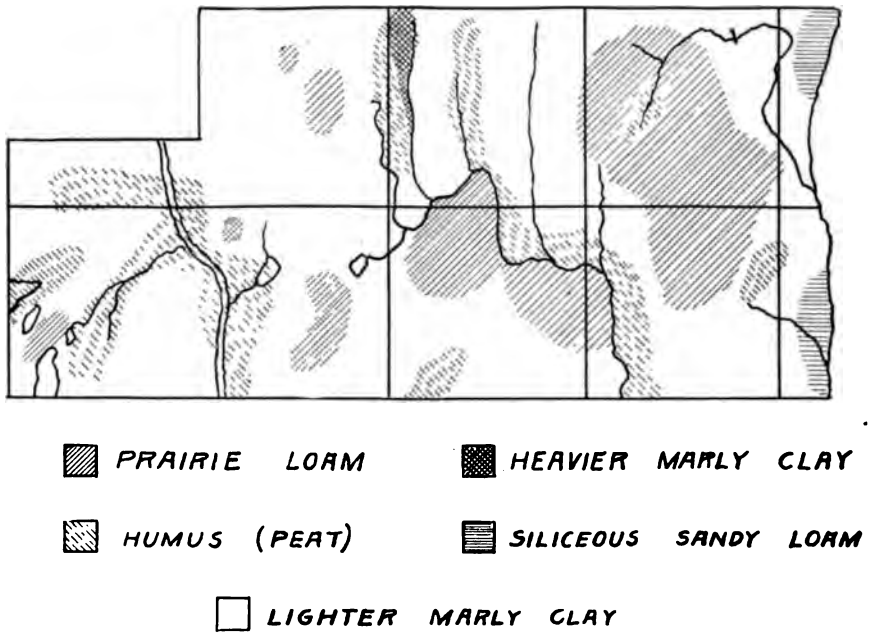
in color, degree of coarseness, time of deposit, and chemical composition. The section in the western part of the county, including the greater part of the towns of Randall and Wheatland, is the region of Kettle Range Moraine Kames. This section composes the extreme southeastern part of the Kettle range. This region is more undulating than any other part of the county, in fact some of the hills are quite abrupt. In this same region and also in the town of Salem there are numerous small moraine lakes, which add much to the beauty of the land. The most important of these lakes are Powers, Elizabeth, Mary, Silver, and Camp.

Adjoining this section to the eastward, and including the eastern part of the towns of Randall and Wheatland, all of Brighton and Salem, and the western part of Paris and Bristol, is the region of bowlder clay. This region is of an earlier formation than that just described and consists of a commingled mass of clay, sand, gravel, and bowlders variously arranged with reference to each other and spread out irregularly over the surface of the limestone bed below.

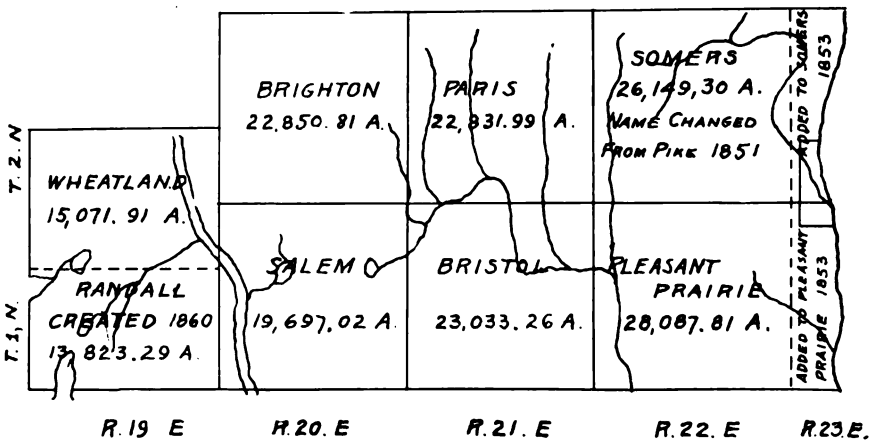
The formations of the other two sections are known as the light colored pebble clay and the beach. The light colored clay covers the greater part of the towns of Paris, Bristol, Somers, and Pleasant Prairie. This formation is very similar to the bowlder clay, and only differs from it in that the bowlders are smaller and the clay is of a lighter color. The beach formation covers the eastern part of the towns of Somers and Pleasant Prairie, extending on an average about one mile inland from the lake shore. At the surface there is a deposit of sand and gravel, with a varying, but subordinate admixture of clayey and marly material. The gravel averages about ten feet in thickness, and is usually fine, and interstratified with sand and occasionally with clay.

The essential features of a drift formation of this sort are its industrial value. The accumulation, deposit, powdering, and commingling of a vast variety of materials by the glacial forces must inevitably result in producing a sub-soil rich in variety of minerals and well suited to give a secure and permanent foundation to agricultural industries.

DISTRIBUTION OF SOILS



BOUNDARY CHANGES



Taking up now the prevailing sub-soils, we find that there are four in the county. They are known as prairie loam, lighter marly clay, humus (peat) heavier marly clay, and silicious sandy loam. Map II shows the location of each. The prairie loam is found chiefly in the central and eastern part of the county. It predominates in the towns of Paris and Somers, while in the four counties in the west there are only small scattered areas. This is a rich, black soil and very responsive to proper fertilizers. Its chief ingredient is silica, with which is associated a variety of soluble mineral substances which exist in abundance in the limestone and drift deposits beneath. These soluble minerals constitute excellent food for plant life.

The lighter marly clay is the predominating soil in the county. It prevails in the same general region as the prairie loam, its areas being interwoven with them. It is a reddish soil and is very durable and fertile. The chief ingredients are calcium and magnesium, and it contains enough of sandy material to make it loamy and easy to work.

The heavier marly clay is a heavier sub-soil than any of the other soils in the county. This soil with the silicious sandy loam constitute the poorer soils of the county, and fortunately they only form a small part of the soil when compared with the area of prairie loam and the lighter marly clay. The chief characteristics of this soil are that it contains a notable amount of lime, magnesia, and silica. The surface is frequently strewn with bowlders, chiefly "hard heads," while cobble stones and pebbles mingle more or less with the soil. The silicious sandy loam is found along the lake shore and is a result of the beach deposit already described. It is a sterile, silicious soil, but when mingled with clay it produces a rich fertile soil well adapted to certain kinds of plant life.

The humus (peat) is found along the Fox and Des Plaines It is a result of the decay of peat and swamp muck, upon which various grasses flourish.[1]

From this study it seems evident, that the soil and contour of Kenosha county are admirably suited for agricultural

[1] This discussion of the Geology, soils and topography, is abridged from Geology of Wisconsin, vol. 2, part 2, 1873–1877.

purposes; that the vast supply and variety of minerals, in the underlying strata, constitute excellent plant food, and insure a permanent foundation for agricultural industries, and that the wealth of the county must depend primarily upon agricultural and dairy pursuits.[1]

Chapter III.

THE PEOPLING OF THE COUNTY.

We now come to the study of the peopling of Kenosha county. During the period of 1836 and the few years just preceding that rivers and in small areas in the low lands throughout the county. time, the great West, its boundless natural resources and its many advantages for the acquiring of wealth was the subject of absorbing attention throughout the Middle and Eastern states. In December, 1834, a resident of the town of Hannibal, Oswego county, N. Y., gave a dinner party to a number of friends. At this dinner the dominant theme of discussion was the West, its beautiful prairies, productive soil, and remarkable possibilities. Members of the party related marvelous tales and glowing descriptions which they had heard from travelers who had explored the country west of the great lakes. The enthusiasm during the evening became so great that before the party broke up those present had mutually resolved upon a plan to organize an association to settle a colony in the West, in which those becoming members should be of assistance to each other, and mutually share profits and losses in the enterprise. Shortly afterwards there was a general meeting of the people of the town called for the purpose of inviting the co-operation of all who desired to join such an enterprise. The meeting was well attended and the object under consideration met with more general favor than was anticipated. At a subsequent meeting, held Feb. 20, 1835, an organization was finally perfected, under the name of the "Western Emigration Company." Peter Woodin

[1] For soils and topography see Plate XXXIX.

and John Bullen, Jr., both of Hannibal, were elected president and secretary of the company.[1]

The constitution of the company proposed to raise a cash capital of $8,000 by subscriptions of stock in shares of $10 each, the funds so raised to be invested in real estate suitable for a town site, and the share-holders to be entitled to the proceeds arising from any increase in the value of the property. The stock of the company promised to be lucrative, and many people of small means, who desired to find a new home in the West, became share-holders. Old men and young men, and even unmarried women, who were employed as house servants, in some instances, appropriated from their earnings sufficient to purchase a share, in the hope of realizing large profits.

In the spring of 1835, the company appointed a committee to explore the distant, and then comparatively little known regions of the west. The explorers left Hannibal March 19, 1835. The account says the day of departure was one of considerable interest to the inhabitants of Hannibal. The instructions to the committee were explicit and reduced to writing. The committee was instructed to examine the country along the western shore of Lake Michigan with a view of finding an elegible situation for a commercial town, with lands in the vicinity adapted to agricultural pursuits. Milwaukee was fixed as the first point the committee was to visit—that being the only place then known between Chicago and Green Bay as being settled by white inhabitants. From Milwaukee they were directed to explore either north or south, along the shore, as they might judge best.

On reaching Milwaukee the committee learned that there were several points on the lake shore toward Chicago capable of being rendered of commercial importance, which were yet unoccupied. Thereupon the committee proceeded southward, exploring such points as they considered afforded a natural advantage for the construction of a harbor. Their first step was at the north of the Root river. The land here was claimed by other parties, but the committee entered into an agreement with

[1] A communication printed in the Kenosha Leader, June 26, 1890, states that John Bullen was originator and organizer of the Western Emigration Co., and was the only individual at any time elected president of the association.

these parties by which they were to pay $2,700 for the claim upon the land upon which the principal part of the city of Racine now stands.

Owing to some misunderstanding the committee was removed and John Bullen, Jr., was made sole agent for the company. On his arrival at Root river, the parties who made the agreement with the committee refused to abide by its terms. An attempt to enforce the agreement failed and Bullen, together with his party proceeded to examine the country further south. On the 6th of June, 1835, the exploring party reached Pike Creek. They were struck by the depth and width of the creek and decided at once to build a town upon its shores. As soon as the news reached Oswego county, immediate preparations were made by stockholders to emigrate to the newly-selected home. About fifteen families, mostly from the town of Hannibal, came on during the summer and fall of 1835. A part of these were not members of the company, and on their arrival, made claims on land in the vicinity of Pike Creek for the purpose of pursuing the business of farming. This was the beginning of the village of Southport, the first village in the county, and which in 1850 became the city of Kenosha.[1]

The Western Emigration Company was dissolved in Dec., 1836. It proved a losing venture to most of the stockholders, but it nevertheless served as an intermediary between the people in New York who were about to emigrate and the new lands of Kenosha county. During the short existence of the company it advertised and made Pike Creek known to a large number of the people of New York. In so doing it must undoubtedly have directed a large part of those emigrating from New York to the West to this point. In our study of the nativity of the population of the county for the two decades from 1850 to 1870, we may therefore expect to find a large percentage of the population born in New York. Table 1[2] shows this to be true in every town in the county.

[1] This account of the first settlement in Kenosha Co. is abridged from the History of Racine and Kenosha Counties, 1879, pages 331-340.

[2] This table was made from copies of the original U. S. census returns for the state for 1850, 1860 and 1870, which are in the vault of the office of the Sec. of State. For the actual number born in the different states and foreign countries see Table 1, Appendix.

TABLE I.— *Nativity by percentage.*

County and Towns.	Year.	New England.	New York.	Middle States, exclud. N. Y.	Wisconsin.	Northwest.	Other States.	British America.	Great Britain, exc. Ireland and B. A.	Ireland.	Germany, exclud. Prussia.	Prussia.	Rest of Europe and Miscellaneous.
Kenosha county ...	1850	11.9	29.6	2.2	18.7	5.3	.2	2.5	9.2	11.7	7.9	.3	.9
	1860	7.8	18.3	1.5	31.6	3.3	.7	1.6	7.5	8.7	4.1	8.6	6.1
	1870	4.9	12.4	1.5	45.3	3.8	.8	1.1	5.6	6.1	3.2	13.4	2.4
City of Kenosha ...	1850	11.4	27.6	1.5	17.4	7.6	.4	2.5	7.3	16.4	6.5	.6	.8
	1860	7.9	15.4	1.0	31.8	4.4	1.8	1.9	5.1	11.8	4.9	6.9	6.9
	1870	6.	11.6	1.1	44.1	5.3	.9	1.6	3.3	7.4	4.3	11.	2 8
Brighton.....	1850	5.5	16.1	4.0	21.2	2.7	.3	3.2	16.4	18.9	10.7	.....	.5
	1860	1.9	7.6	.9	38.	1.3	...	.6	14.5	10.4	2.2	19.9	2.6
	1870	.5	3.0	.6	54.3	.5	.3	.4	8.1	7.4	1.1	22.5	1.1
Bristol.....	1850	20.8	39.	3.3	18.8	5.5	.....	1.3	1.7	4.7	4.0	.....	.5
	1860	12.3	31.8	1.4	26.7	5.4	.1	1.8	1.4	7.9	.9	2.1	7.5
	1870	10.3	22.3	.7	41.6	6.4	1.4	.3	2.2	6.4	1.0	5.3	1.7
Paris.....	1850	6.8	28.7	1.2	19.4	4.8	.1	.6	15.2	7.3	11.1	1.0	2.7
	1860	5.9	15.4	1.7	34.2	1.3	.1	.4	13.4	5.9	7.6	10.5	3.5
	1870	3.8	6.5	.8	46.9	1.0	.9	.6	12.7	4.1	4.9	12.4	4.8
Pike	1850	13.6	29.7	1.0	20.8	4.5	.5	.9	13.	5.4	10.	.1	.....
	1860	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	1870	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Pleasant Prairie ..	1850	11.9	19.2	1.2	21.4	2.2	.1	1.8	16.8	19.6	3.5	.....	1.2
	1860	9.1	15.6	.9	29.6	1.5	.6	.9	10.1	11.1	4.5	2.6	13.1
	1870	4.7	13.1	6.5	39.1	1.6	1.3	.8	7.9	10.7	2.9	8.8	2.4
Randall.....	1850	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	1860	7.6	29.6	6 6	29.1	3.6	.1	1.2	7.5	6.2	2.8	1.5	7.2
	1870	3.0	20.4	1.5	46.5	6.1	.....	.1	4.5	2.6	.5	13.5	.9
Salem.....	1850	13.	36.1	2.3	17.1	3.5	.4	8.1	8.8	5.1	1.4	.....	.5
	1860	10.4	24 9	1.2	31.4	5.5	.6	2.9	9.5	8.6	.3	2.8	1.7
	1870	6.2	18.1	.8	42.8	5.2	1.	1.1	8.0	6.6	1.0	7.3	1.4
Somers.....	1850	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	1860	5.9	20.4	.6	33.4	2.3	.1	2.5	10.8	4.4	4.3	8.9	6.1
	1870	3.6	14.8	1.2	45.5	2.5	.8	1.7	9.5	1.8	4.4	10.6	3.4
Southport	1850	20.1	34.9	1.1	15.4	4.2	.....	3.	7.7	6.9	5.5	.5	.8
	1860	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	1870	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Wheatland	1850	8.9	35.2	4.4	19.2	6.0	.08	.5	4.6	4.2	15.7	.08	.8
	1860	3.3	12.4	3 1	33.	2.3	.2	1 3	.4	3.0	7.5	28.4	4.5
	1870	1.0	4.5	.1	57.3	2.5	.1	1.5	1.2	.8	5.6	28.8	1.9

Coming now to a more careful study of the results in Table 1, we find that as late as 1870 only two towns, Brighton and Paris, had a population of over 50% born in Wisconsin. Of the total population of the entire county in 1870 only 45.3% were born in Wisconsin. This shows plainly that the bulk of the population in 1870 and previously, was born either in other states or in foreign countries.

The population of the city of Kenosha in 1850 consisted mainly of those born in New York, Wisconsin, Ireland, New England and Great Britain. In 1860 and 1870 the percentages of the population furnished by these states and countries fall, while that of Wisconsin and Prussia rise. The rise in the percentage of the Wisconsin born is to be expected,[1] but the rise of the percentage of those born in Prussia shows the coming in of a large number of Germans during the two decades.[2] The large decline in the percentage of the New York element from 29.6% to 18.3% between 1850 and 1860, and from 18.3% to 12.5% between 1860 and 1870 indicates very plainly that a large number of those born in New York left the city and went elsewhere. The falling off of the Irish element indicates the same thing, but not to such an extent as in the case of the New York element.

A large percentage of the population of the towns of Brighton, Paris and Wheatland in 1850 were from New York, New England, Ireland, and Great Britain. Between 1850 and 1870 a large part of the New York and New England population left the towns; especially is this true in the towns of Wheatland and Paris, where the New England element sank from 6.8% to 3.8% in Paris, and from 8.9% to 1% in Wheatland, and the New York element from 28.7% to 6.5% in Paris, and from 35.2% to 4.5% in Wheatland. The English and Irish elements remained in the three towns and naturally declined a little each year, with the exception of the town of Brighton. The fall of the percentage of the Irish in this town from 18.9% to 10.4% between 1850 and 1860 shows that part of the Irish emigrated. The most important feature of Brighton and Wheatland is the rapid increase in the number of Germans, chiefly from Prussia. The number of Germans increased slightly in the town of Paris, but not to such a degree as in these other two towns. By 1870 these three towns were mainly settled by people of a foreign nationality. Wheatland was chiefly settled by Germans, Brighton by Germans, English and Irish, and Paris by Germans and English.

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[1] Those born in Wisconsin rapidly increased, so the Wisconsin born is an important factor in each town.

[2] The percentage of the Germans who were born in Prussia is so great, that hereafter in this discussion the term German will mean those who were born in Prussia.

The town of Pleasant Prairie has a characteristic of its own. In 1850 the percentage of the population born in Ireland and Great Britain was greater than that of those born in New York and New England, while in 1860 those born in New York and New England were greater than those born in Ireland and Great Britain, and in 1870 they were about equal. The noticeable sinking in the percentages of the Irish and English elements from 19.6% to 11.1% and from 16.8% to 10.1%, respectively, during the first decade makes it very plain that the Irish and English elements either settled in the town and then left, or that they settled in what was Pleasant Prairie in 1850, and when the southern part of the town of Southport was annexed in 1851, the great predominance of the New York and New England elements in the district added, offset the large percentage of Irish and English which existed in Pleasant Prairie in 1850. By examining the actual number of the population born in New York, New England, Ireland, and Great Britain in the town of Pleasant Prairie and Southport in 1850, and in the town of Pleasant Prairie for 1860 and 1870 in Table 1 of the Appendix, the latter statement will be seen to be true. So it is evident that if any of the English and Irish elements emigrated from this town they did not do so in such great numbers as the New York and New England elements. The German element increased steadily during the period.

The towns of Bristol, Somers, formerly Pike, Salem, and Randall, are the ones which show the least thinning out of the New York and New England population, but the fall in the percentages, however, is greater than it would ordinarily be, providing no emigration of these elements had taken place. In all of these towns there was a small increase in the number of Germans. The town of Randall shows the greatest increase. From 1860 to 1870 the German element in this town rose from 1.5% to 13.5%. The town of Bristol was settled chiefly by the New York and the New England population. In 1850 the New York element was 39% and the New England 20.8%, making together 59.8% of the total population of the town. From 1850 to 1860 there was a slight increase in the number of Irish and from 1860 to 1870 a small increase in the number of Eng-

lish. The New York and New England elements nevertheless remained the predominating population of the town. Salem, like the town of Bristol, was settled by the New York and New England people, and they remained the prevailing elements in the town. During the first decade quite a number of Irish and English came in and settled. There was also a small but steady increase in the German population. The towns of Somers and Randall, although Randall was not formed until 1860, show a greater increase in the number of Germans than the other two towns. In Somers those born in New York, Germany, chiefly Prussia, Ireland, and Great Britain, were the greatest in number, while in Randall, those born in New York and Germany predominated.

To sum up the study of the accompanying Table 1 and Table 1 of the Appendix, we find: 1. That the nativity of the population of the county, according to relative importance, takes the following order: in 1850, New York, Wisconsin, New England, Ireland, Great Britain and Germany; in 1860 Wisconsin, New York, Ireland, Prussia, New England and Great Britain; and in 1870, Wisconsin, New York, Prussia, Ireland, Great Britain and New England. 2. That the population furnished by New York and New England declined steadily and rapidly since 1850, not so much by natural decline, as by emigration from the county. Those that remained in the county massed in the towns of Bristol, Salem, Randall, Somers, and a large number in Pleasant Prairie. 3. That the Irish have steadily declined since 1850. They scattered in the county, but settled chiefly in Pleasant Prairie, Brighton, and the city of Kenosha. They are the only foreign nationality that had a tendency to emigrate. From 1850 to 1860 a large number left the city of Kenosha and the town of Brighton, some leaving the county, and others moving into the towns of Bristol and Salem. 4. That the English in the county increased slightly from 1850 to 1860, and settled mainly in the city of Kenosha, Brighton, Paris, Pleasant Prairie, Salem and Somers. The only town in which there is an indication that a small number emigrated after settling is Brighton. 5. That the total number of Germans in the county, chiefly from Prussia, increased nearly 145%

from 1850 to 1870. They scattered all over the county, but massed principally in the towns of Brighton and Wheatland. 6. That the foreign nationality predominated in Brighton in 1860.

TABLE 2.— *Nativity of county and town by percentage.*

	NATIVE.			FOREIGN BORN.		
	1850.	1860.	1870.	1850.	1860.	1870.
Kenosha county	68.2	65.6	69.1	31.8	34.4	30.9
Kenosha city	66.6	64.7	68.4	33.4	35.3	31.6
Brighton	50.2	49.7	59.3	49.8	50.3	40.7
Bristol	87.6	81.9	82.9	12.4	18.1	17.1
Paris	60.7	59.1	60.7	39.3	40.9	39.3
Pike–Somers	70.4	65.8	68.7	29.6	34.2	31.3
Pleasant Prairie	57.0	66.3	66.7	43.0	33.7	33.3
Randall	....	78.9	78.3	....	21.1	21.7
Salem	75.8	74.7	74.3	24.2	25.3	25.7
Southport	75.6	....	....	24.4	....	....
Wheatland	73.7	54.9	60.8	26.3	45.1	39.2

Note.—For the total number of native and foreign born in the county and towns for the three years, see Table 2, Appendix.

To further show the distribution of the foreign and native population in the county and towns, Table 2 was made by considering all born within the United States as native, and all born outside as foreign, for the three years 1850, 1860 and 1870. Taking the percentages of the native and foreign born in each town for each of the three years, and comparing them with the percentages of the native and foreign born of the entire county for the same years, one readily sees that in 1850 the towns of Bristol, Salem, Southport, and Wheatland were settled mainly by native born. In the towns of Somers, then Pike, and the city of Kenosha, the native born were about the same as the county average, the former being a little above and the latter a little below. In the towns of Brighton, Pleasant Prairie, and Paris, the percentage of native born falls below that of the entire county, which indicates strongly the presence of a large foreign element in these towns. In 1860 the per-

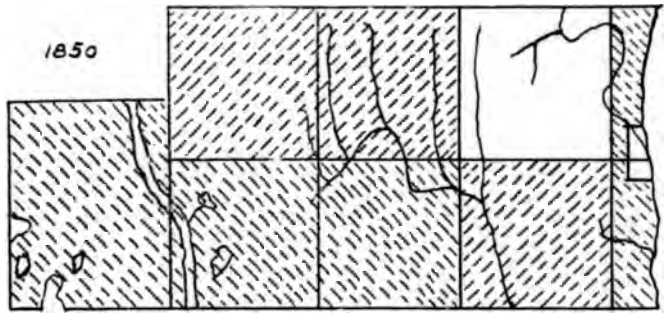
centages of the native and foreign born of these various towns bear about the same relation to that of the entire county as they did in 1850, except Pleasant Prairie and Wheatland. When Southport was divided and the southern part added to Pleasant Prairie, the evident predominance of the New York and New England elements in this district, had the effect of raising the percentage of the native born in this town from 57% in 1850 to 66.3% in 1860, which is .7% above the county average in 1860. The town of Randall, which was formed out of what was a part of Wheatland in 1850, has a percentage of native born of 78.9%, or 13.3% above that of the county, while the percentage of the native born of what is left of Wheatland, after the division, sinks to 54.9%, or 10.7% below the county average. This is a strong indication that, while the town was not arbitrarily divided in 1850, it was nevertheless naturally divided by the settlement of the foreign elements in the northern part and the native in the southern part. This fact may have been what led to the division of Wheatland in 1860. In 1870 the percentage of the native born in Pleasant Prairie again sinks below the county average, while the percentage of the native and foreign born for the other towns maintain about the same relation to the county average as they did in 1850 and 1860.

The sub-joined maps in Plate XL. show very clearly the location of the native and foreign elements in the county in 1850, 1860, and 1870, and verify the conclusion drawn from Table 1 in regard to the location of the foreign elements.

DISTRIBUTION OF NATIVE & FOREIGN POPULATION

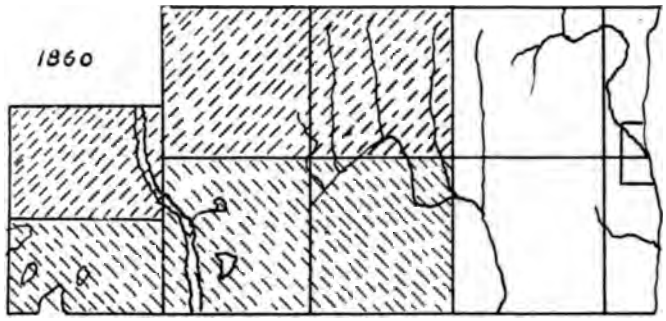
COUNTY AVERAGE NATIVE 68.2% FOREIGN 31.8%

1850



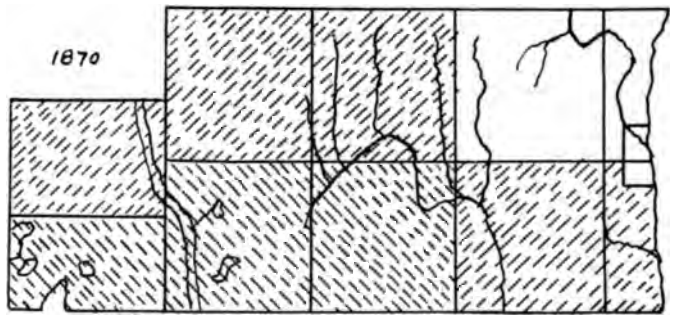
COUNTY AVERAGE NATIVE 65.6% FOREIGN 34.4%

1860



COUNTY AVERAGE. NATIVE 69.1% FOREIGN 30.9%

1870



ABOUT COUNTY AVERAGE

BELOW " "

ABOVE " "

Chapter IV.

Density of Population, Valuation per Capita and Occupation.

Taking up first the subject of population, it will be observed from Table 3 that the population per square mile from 1850 to 1900 for the entire county, including the city of Kenosha, has steadily increased, but with considerable variation. Between

Table 3.— *Density of Population.*

	Area in square miles.	Population Per Square Mile.					
		1850.	1860.	1870.	1880.	1890.	1900.
Kenosha county	268.04	40.3	50.4	49.1	50.7	58.0	80.9
City of Kenosha	1.25	2831.2	3193.6	3447.2	4031.2	5225.6	9284.8
Co. of Ken. (exclud'g city).	266.79	27.7	35.6	33.5	31.7	33.7	37.8
Brighton	35.7	24.6	32.9	33.2	28.7	25.7	23.8
Bristol	35.98	31.2	38.1	31.7	29.7	29.9	32.3
Paris	35.67	26.8	34.2	28.4	28.9	24.6	22.4
Pike–Somers	40.07						
	35.42	19.2	31.9	33.9	36.4	40.7	50.1
Pleasant Prairie	43.41						
	35.93	26.7	32.2	31.7	32.0	37.9	40.9
Randall	21.59	.....	30.5	24.7	20.9	30.5	36.3
Salem	30.77	36.5	46.9	45.0	42.3	48.7	60.2
Wheatland	21.59						
	45.15	26.4	51.6	40.3	38.7	34.8	38.5

Note.—The area of Pike before changed to Somers was 35.42 sq. miles. The area of Pleasant Prairie before the northern part of Southport was set off was 35.93 sq. miles, and the area of Wheatland before Randall was set off was 45.15 sq. miles.

1860 and 1890 there was only a very small increase of population, but from 1880 to 1900 there was an increase of 30.2 to the square mile. The largest and most consistent growth of population took place in the city of Kenosha. The population to the square mile for the county, not including the city of

Kenosha, varies greatly. Starting with 27.7 to the square mile in 1850, it reaches 35.6 in 1860, sinks to 31.7 in 1880, and again increases to 37.8 in 1900. Somers is the only town in the county which has a steady and constant increase. The town of Pleasant Prairie attains its maximum density in 1900. Between 1860 and 1880 the population to the square mile slightly declined. Considering the inland towns, which have a predominance of foreign elements, namely Brighton, Paris, and Wheatland, as Group 1, and those which have a predominance of native born, namely, Bristol, Salem and Randall, as Group 2, it will be seen that the population of Group 1 tends, with considerable variation, to decline, while that of Group 2 tends to steadily increase. The towns composing Group 1 attain their maximum density of population in 1860 and 1870, while those in Group 2 reach their maximum density in 1890 and 1900. The fluctuation of the population of the town of Wheatland is more marked than any other town in the county. In 1850 the population to the square mile in this town was 26.4, in 1860, 51.6, in 1870, 40.3, and in 1900, 38.5.

Plate XLI shows those towns in which the population has declined, and Chart I, Plate XLII, shows graphically the rise and fall of population in each town from 1850 to 1890.

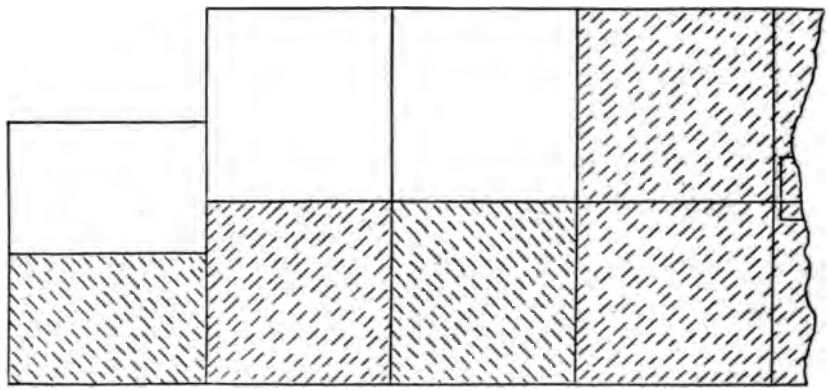
TABLE 4.— *Valuations per capita.*

GROUP 2.	Year.	Cash value of farms.	Total valuation.
Towns having native-born population	1850	$252.9	$80.89
	1860	667.2	287.8
	1870	659.5	584.9
GROUP 1.			
Towns having largest foreign-born population....	1850	214.2	96.39
	1860	285.0	273.9
	1870	619.8	467.1

NOTE.— See Table 4, Appendix, for the cash value of farms and the total assessed valuation of the county and towns for 1850, 1860, and 1870.

Having seen that the population in the towns of Group 1 has declined, while that of the towns of Group 2 has increased, let us now compare the cash value of the farms per capita and the total valuation of the personal and real estate per capita of Group 1 for 1850, 1860, and 1870, with that of Group 2 for the

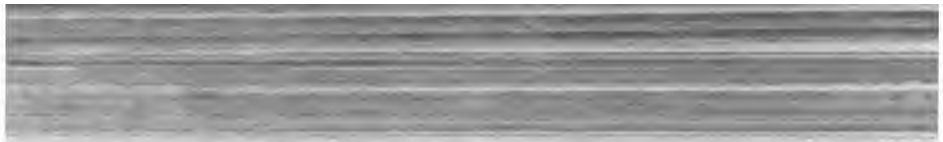
FLUCTUATIONS IN POPULATION FROM 1850-1900



DECLINE

INCREASE UNDER 50%

INCREASE OVER 50%



same years. The figures in Table 4 show that the cash value of the farms per capita is greater in Group 2 than in Group 1 for the years under consideration. The same is true of the total valuation of personal property and real estate per capita, except that in 1850 that of Group 2 is less than that of Group 1. This exception may be partly accounted for by the fact that there seems to have been a great demand and rush for the farms in Wheatland and Brighton during the period from 1850 to 1860, due to the excellent quality and quantity of the wheat grown in this section.[1] The fact that these valuations per capita are greater in Group 2 than in Group 1 may be regarded as an indication that the native born were more thrifty and made greater improvements on their farms than the foreign born.

This decline in the population in the towns of Group 1, and the fact that the cash value of the farms per capita is lower on the whole than that of Group 2, leads us to examine the products of the towns of the two groups. Chart II, Plate XLII, shows graphically the fluctuation of the chief products of the county, excluding the city of Kenosha, from 1850 to 1895. The most striking fact shown is the steady decline of the number of bushels of wheat per capita and the great increase in the number of pounds of butter and bushels of oats per capita. The result in Table 6 of the Appendix points out clearly that there was a strong tendency in the towns of Group 1 to depend upon the production of wheat, oats, and Indian corn, while the towns of Group 2 went into the dairy industry. In the study of the soils of the county it was pointed out that the prevailing soil in the western area of these two groups of towns is the lighter marly clay and in the eastern area, including the towns of Paris and Bristol, there is a considerable amount of prairie loam, especially in Paris. This fact leads irresistibly to the conclusion that the decline in the population and the smallness of the cash value of the farms and the total valuation per capita of Group 1, when compared with that of Group 2, is due not so much to the soil as to the nativity of the people. The Germans, English,

[1] See Table 6, Appendix. The census taker of 1850 in his remarks on the town of Wheatland said that the town had a great reputation for wheat.

and Irish evidently lacked the ability to adapt themselves to the economic changes and agricultural improvements; on the other hand, the native born of Group 2 took advantage of such changes and improvements.

TABLE 5.— *Profession, occupation, or trade of the males over 15 years of age in Kenosha county, excluding the city, by total and percentage.*

	TOTALS.			PERCENTAGE.		
	1850.	1860.	1870.	1850.	1860.	1870.
Farmers	1,567	1,324	1,429	73.9	43	52.7
Artisans and mechanics	133	104	112	6.3	3 08	4.07
Small trades and professions	44	42	58	2.01	1 3	2.1
Petty tradesmen	10	4	8	.47	.1	.3
Laborers	336	806	907	15.8	26.4	32.8
Professional men	23	40	38	1.08	1.3	1.3
Capitalists and merchants	5	18	43	.23	.6	1.56
Miscellaneous	.....	712	161	.....	23.3	5.8

NOTE.—For the percentage of occupation in each town see Table 5, Appendix.

The principal occupation of the males of the county, excluding the city of Kenosha, is farming. In 1850 of the total number of males over fifteen years of age, as will be seen from Table 5, 73.9% were farmers, in 1860, 43%, and in 1870, 52.8%. The laborers in 1850 constituted 15.8% of the males, 26.4% in 1860, and 32.8% in 1870. The decrease in the number of farmers from 1850 to 1870, and the increase in the number of laborers would seem to indicate the concentration of the farm lands into the hands of a few large and wealthy farmers, the many small farmers finding employment as laborers.

To conclude we find: 1. That the population of the county has steadily increased, but with a considerable variation. The greatest increase has taken place in the city of Kenosha, the coast towns, and the town of Salem. 2. That the towns which show a marked decline in population and a lower cash value of farms and a total valuation per capita, are the towns settled by foreign born, chiefly Germans, English, and Irish. The only

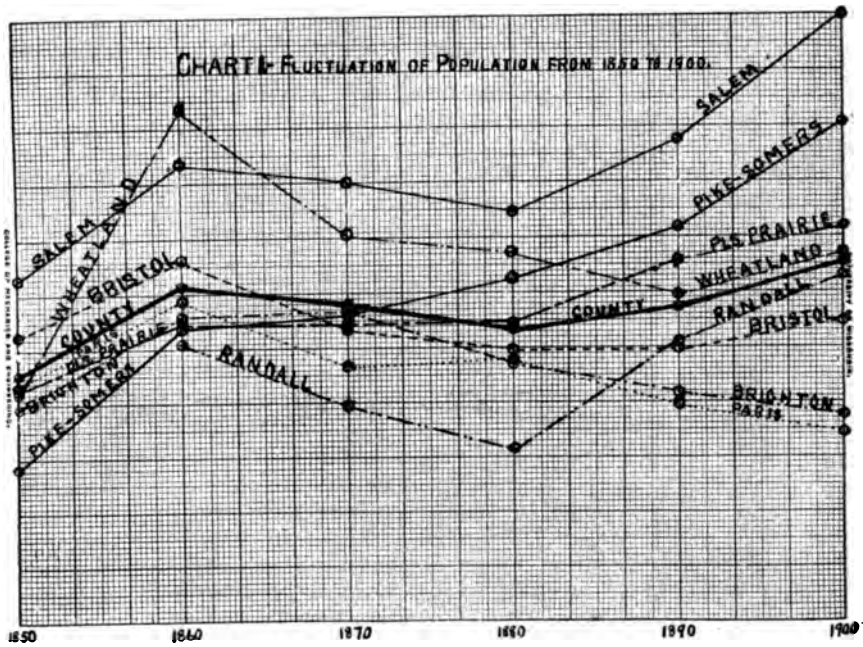


CHART I.- FLUCTUATION OF POPULATION FROM 1850 TO 1900.
SALEM
PIKE-SOMERS
PLEASANT PRAIRIE
WHEATLAND
RANDALL
BRISTOL
BRIGHTON
1850
1860
1870
1880
1890
1900

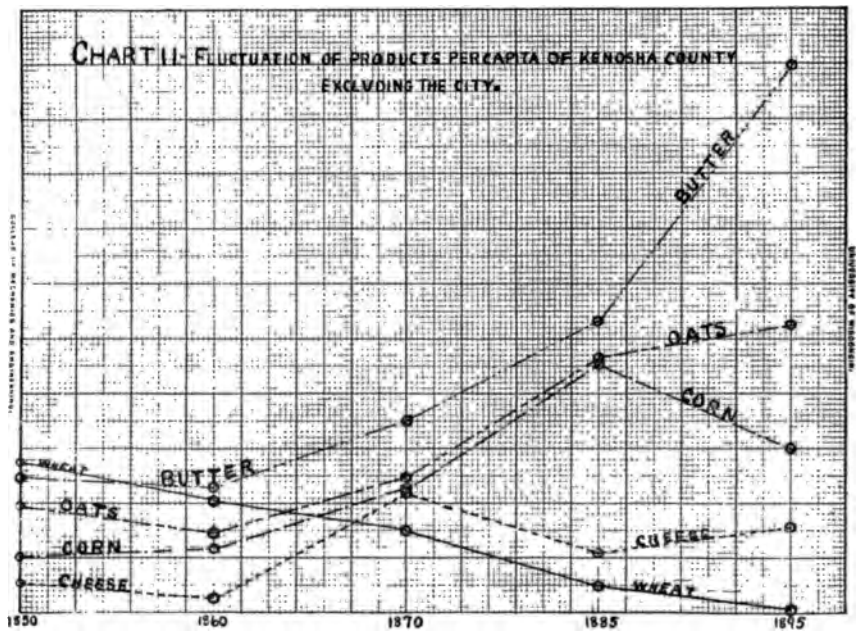


CHART II- FLUCTUATION OF PRODUCTS PER CAPITA OF KENOSHA COUNTY EXCLUDING THE CITY.
BUTTER
OATS
CORN
CHEESE
WHEAT
1850
1860
1870
1885
1895

exception is the town of Pleasant Prairie, in which the foreign elements are mainly English and Irish. 3. That the decline in population and valuations per capita is due not so much to the soil as to the nativity of the occupants; and 4, that the principal occupation of the county is farming.

Chapter V.

A study of the population by nativity and occupation in 1850.

The following tables were prepared in order to get an idea of the class of the people that had just settled in Kenosha county, or were on the move in 1850. Table 6 gives the number and per cent. of the males over fifteen years of age in each occupation. From the table it will be seen that a little over one-half of the male population were farmers, while 18.1% were laborers, and 12.6% were artisans and mechanics.

Table 7 shows the percentage of males in each occupation, with and without wealth. The striking feature of this table is the excellent condition of the farmers. Slightly over one-half have more or less wealth. Aside from the capitalists and the merchants, the next best off in order are the artisans and mechanics and the smaller trades and professions.

Table 6.— *Occupation, number, and per cent.*

	Number.	Per cent.
Farmers	1,620	51.7
Artisans and mechanics	395	12 6
Smaller trades and professions	221	7.0
Laborers	569	18 1
Petty tradesmen	118	3 7
Professional men	82	2.5
Capitalists and merchants	46	1.1
No occupation	82	2.5

TABLE 7.— *Percentage in each occupation of those with and without wealth.*

	With.	Without.
Farmers	50.7	49 3
Artisans and mechanics	40.7	59.3
Smaller trades and professions	37.1	62.9
Laborers	17.9	82.1
Petty tradesmen	31.3	68.7
Professional men	47.5	52.5
Capitalists and merchants	97.8	2.2

From Table 8 it is seen that the Middle States furnished more males with and without wealth than New England or the miscellaneous states. The number in each occupation without wealth, except the capitalists and merchants who came from the Middle States, is greater than those with wealth. On the other hand, those who came from the New England states are less in number, but those with wealth in each occupation is greater than those without, and the average wealth in each occupation on the whole is greater than that of the Middle States.

The most noticeable thing in Table 9 is that the average wealth in each occupation of the native born is much larger than that of the foreign born. The number of farmers born in foreign countries who have wealth is greater than those who have no wealth, while the number of native born farmers who have wealth is less than those who have no wealth.

The object in preparing these tables and pointing out a few of the facts which the figures in the table show, was simply to indicate that there is a possibility of reaching valuable conclusions as to the nature of the emigration movement in 1850, by studying the occupation, the nativity and wealth of those who first settled in the county, and taking them as typical of the emigration that moved further forward.

TABLE 8.— *Number and wealth of those from the Eastern States.*

	NEW ENGLAND.			MIDDLE STATES.		
	Without.	With.	Average.	Without.	With.	Average.
Farmers	129	161	$3,337.6	355	319	$2,461.15
Artisans and mechanics ..	35	36	1,089.7	82	60	879.13
Smaller trades and professions	26	26	2,273.4	58	20	8,879.9
Laborers	16	2	1,150.	74	6	508.3
Capitalists & merchants.	.....	16	17,166.8	.....	25	16,345.5
Professional men	12	17	4,226.4	20	15	2,640.
Petty trades	18	11	747.27	28	7	1,712.8

TABLE 9.— *Proportion by occupation of native and foreign-born and the wealth of the native and foreign-born of each occupation.*

	NATIVE.			FOREIGN.		
	With.	Without.	Average.	With.	Without.	Average.
Farmers	508	487	$1,144.4	289	334	$1,233.4
Artisans and mechanics.	131	100	846.78	100	61	676.2
Smaller trades and professions	91	49	3,652.4	43	30	980.
Laborers	101	8	618.8	343	82	476.7
Capitalists & merchants.	.....	42	11,925.6	.....	3	8,680.
Professional men	35	32	3,482.8	7	7	507.1
Petty trades	48	20	1,087.	33	18	715.

Chapter VI.

SOME CORRECTIONS IN THE UNITED STATES AND STATE CENSUS REPORTS FROM 1850 TO 1870.

It was discovered upon comparing the results obtained in this study with those of the United States and State Census returns that there were considerable variations. The following tables show the differences for the years 1850, 1860, and 1870. In column one the population is given which was obtained from the records already referred to. Columns 2 and 3 show these variations from the United States Census returns. The plus sign before the number indicates that the returns for the towns exceed and the minus sign that they are less than those found in the records. The blanks indicate that there is no variation.

In getting the results from the records a table similar to Table 11 was used. The number of persons on each page of the Census report from each separate state or country was counted and the result placed in a small square opposite the name of the state or country. When all the names on the page were classified according to nativity, the column was added and the result placed below. Then to make sure that no names were omitted, the names on the page were counted and placed above the column. This result had to correspond to the footing if the work was correct. When all the material for a town was examined the number from each state or country was added and the same placed in a column to the right. To still further avoid a mistake and to be positive that the results were correct, the horizontal and vertical columns of sums were added, and if these results were equal the work was considered correct.

TABLE 10.— *Correction of the U. S. and State Census.*

Town.	Population.	United States Census.	Wisconsin Blue Book.
1850:			
Brighton	880	.....	.....
Bristol	1,125	.....	.....
Kenosha city	3,539	— 84	.....
Paris	956	.....	.....
Pike	680	.....	.....
Pleasant Prairie	959	.....	.....
Salem	1,123	.....	.....
Southport	363	.....	.....
Wheatland	1,193	.....	.....
1860:			
Brighton	1,173	— 65	— 3
Bristol	1,369	— 17	— 1
Kenosha city	3,992	— 24	— 3
Paris	1,085	—289	— 3
Pleasant Prairie	1,400	.....	— 1
Randall	660	— 2	— 1
Salem	1,444	— 28	— 1
Somers	1,278	— 1	— 3
Wheatland	1,115	— 20	.....
1870:			
Brighton	1,187	— 2	— 2
Bristol	1,140	.....	.....
Kenosha city	**4,307**	**— 2**	**— 2**
Paris	**1,014**	**— 1**	**— 1**
Pleasant Prairie	**1,377**	.....	.....
Randall	**533**	.....	.....
Salem	**1,386**	.....	.....
Somers	**1,359**	.....	.....
Wheatland	**871**	**— 28**	**—28**

Table 11.—***Method used in obtaining the accurate Population by nativity in county and towns of Kenosha.***

Randall, 1860.

	40	77	78	76	77	79	79	78	76		
New York	9	9	25	32	32	17	32	17	19		=192
Wisconsin	15	10	28	18	13	23	20	21	27		=175
Massachusetts	3						2	2	4		= 11
Connecticut			1	3	3				4		= 11
New Hampshire											= 0
Vermont	1	4	2	1	6	6	2		1		= 23
Pennsylvania			9	1		14	8	2	1		= 35
Ohio				2		2	2		4		= 10
Illinois			2	2			2	4	1		= 11
Canada					4			1	2		= 7
England	5	4	3	1	4	2	5				= 24
Ireland	6	5	4	2	6	4		11	3		= 41
Germany		1	2	1			1	2			= 7
Rhode Island	1							1	1		= 3
Not given		39	2		3		1		1		= 46
New Jersey		3			1		2		3		= 9
Holland				1		1					= 2
Saxony				7					1		= 8
Michigan				1	2						= 3
Prussia				2	1	1	2	1	3		= 10
Baden				2							= 2
N. Carolina					1						= 1
Brunswick						1					= 1
Isle of Man						7		7			= 14
Wittenburg						1					= 1
Wales								9			= 9
Luxemburg									1		= 1
Scotland		2			1						= 3
	40	77	78	76	77	79	79	78	76	=660	=660

Chapter VII.

ANALYSIS OF THE ELECTION RETURNS FOR PRESIDENTIAL ELECTORS, MEMBERS OF CONGRESS, AND GOVERNORS OF THE STATE.

Since it has been shown in the preceding chapters that the towns of the county in which the native born predominate show an increase in population and wealth, while those towns settled by the foreign born, chiefly Germans, English and Irish, show a marked decline in population and a decrease in wealth, it becomes an interesting and an important feature of this study to investigate the political associations of the people of each town and group of towns.

To consider the votes of the towns for one or two elections would be inaccurate and useless, on account of the many local and personal considerations brought to bear in every election. These influences, however, may be eliminated by combining the

Table 12.— *Combined vote for presidential electors, congressmen, and governors, 1859–1900.**

	Republican.		Democratic.	
	Vote.	Per cent. of total.	Vote.	Per cent. of total.
Kenosha county	67,532	55	56,352	45
Kenosha city	25,188	49	25,941	51
Brighton	2,868	35	5,221	65
Bristol	7,273	75	2,360	25
Paris	3,740	49	3,910	51
Pleasant Prairie	7,135	58	5,035	42
Randall	3,329	66	1,699	34
Salem	8,311	66	4,335	34
Somers	8,011	68	3,662	32
Wheatland	2,677	38	4,024	62

*These figures are taken from the Wisconsin Blue Books.

votes for the candidates of the leading political parties, respectively, for a series of years. Table 12 shows the combined result of all the votes cast in the county, city of Kenosha, and in each town for the Republican and Democratic candidates for presidential electors, members of congress, and governors from 1859 to 1900, with the exception of a few elections of member of congress and governor, for which it was impossible to obtain the election returns by towns. From this table it is seen at once that the strength of the Republican party is in the towns of Bristol, Somers, Salem, and Randall, while that of the Democratic party is in the towns of Brighton, Wheatland, Paris, Pleasant Prairie and in the City of Kenosha. The strongest Republican town in the county is Bristol and the strongest Democratic town is Brighton. Seventy-five per cent. of the combined vote of the former from 1859 to 1900 was cast with the Republican party, while sixty-five per cent. of the total vote for the same period in the latter town was cast with the Democratic party.

On referring to table 9 of the Appendix it will be seen that in not a single election did the town of Bristol go democratic or the town of Brighton republican. The towns of Salem and Somers have gone republican in every election, and the town of Wheatland has gone democratic in every election except in the last congressional election when the election was a tie, and in the last two presidential elections, in which the Republican candidate received a slight majority. These facts are very important when the measures advocated by these two parties during this series of years are considered.

By combining the votes cast in the inland towns of the county into the same groups, which were used in the chapter on the

TABLE 13.— *Vote for presidential electors, congressmen and governors, 1859–1900.*[1]

	REPUBLICAN.		DEMOCRATIC.	
	Vote.	Per cent. of total.	Vote.	Per cent. of total.
Group I.....	9,285	41	13,215	59
Group II.....	18,913	69	8,394	31

[1] Vote of county, city and lake shore towns not included.

density of population, valuation per capita, and occupation, we find from table 13 that of the total vote cast in Group I, 41 per cent. was for the Republican candidates and 59 per cent. for the Democratic. In Group II, 69 per cent. of the total vote cast was for the Republican and 31 per cent. for the Democratic candidates.

From these results we must conclude that there is a strong indication of a close connection between the political, social, and economic conditions of the people. Those towns in Kenosha county in which the foreign born predominate, and in which there has been a decline in population and a decrease in wealth, furnished the strength of the Democratic party, while the strength of the Republican party is in those towns in which the native born predominate and in which there has been a marked increase in both population and wealth.

APPENDIX.

TABLE 1.— *Population by nativity for 1850, 1860 and 1870.*

NATIVE BORN.

County and Towns	Years.	New England.	New York.	Middle states excluding New York.	Wisconsin.	Northwest.	Miscellaneous states.
Kenosha county...	1850	1,300	3,203	243	2,025	579	31
	1860	1,016	2,483	210	4,286	457	100
	1870	646	1,640	203	5,959	504	116
City of Kenosha..	1850	419	965	55	615	268	16
	1860	318	618	42	1,262	176	73
	1870	259	501	49	1,908	230	40
Brighton	1850	49	143	36	187	24	3
	1860	23	89	11	446	16	.....
	1870	6	36	7	645	6	4
Bristol	1850	234	439	38	213	62	.....
	1860	171	438	20	368	74	1
	1870	117	254	10	475	73	16
Paris	1850	65	271	12	186	46	1
	1860	65	168	19	371	15	2
	1870	40	68	9	476	11	10
Pike	1850	93	202	7	142	31	4
	1860	.....	.....	.....	.....	.....	.....
	1870	.....	.....	.....	.....	.....	.....
Pleasant Prairie	1850	114	193	12	205	21	1
	1860	128	218	13	415	22	9
	1870	65	179	90	538	22	19
Randall	1850	.....	.....	.....	.....	.....	.....
	1860	48	192	44	175	24	1
	1870	16	109	8	248	53	.....
Salem	1850	146	444	26	192	40	5
	1860	150	362	18	452	73	9
	1870	85	251	12	594	73	14
Somers	1850	.....	.....	.....	.....	.....	.....
	1860	76	260	8	429	30	2
	1870	49	202	17	618	34	12
Southport	1850	73	126	4	56	15	.....
	1860	.....	.....	.....	.....	.....	.....
	1870	.....	.....	.....	.....	.....	.....
Wheatland	1850	107	420	52	229	72	1
	1860	37	138	35	368	27	3
	1870	9	40	1	457	22	1

FOREIGN BORN.

County and Towns.	Years.	British America.	Ireland.	Rest of Great Britain.	Prussia.	Rest of Germany	Rest of Europe and Miscellaneous.
Kenosha county ..	1850	272	1,227	1,004	36	201	97
	1860	225	1,177	1,012	1,168	549	836
	1870	150	807	777	1,622	428	322
City of Kenosha..	1850	90	574	257	22	229	29
	1860	77	471	203	277	197	278
	1870	71	320	144	476	185	124
Brighton	1850	28	167	144	.....	94	5
	1860	7	122	171	234	26	31
	1870	5	88	96	267	14	13
Bristol	1850	15	53	19	.....	46	6
	1860	25	108	19	29	13	103
	1870	4	73	25	61	12	20
Paris	1850	6	75	152	10	106	26
	1860	5	64	146	109	83	38
	1870	6	41	128	126	50	49
Pike	1850	6	37	89	1	68	.....
	1860	.....	.....	.....	.....	.....	.....
	1870	.....	.....	.....	.....	.....	.....
Pleasant Prairie .	1850	18	188	161	.....	34	12
	1860	13	156	142	37	63	184
	1870	11	148	110	122	40	33
Randall	1850	.....	.....	.....	.....	.....	.....
	1860	8	41	50	10	19	48
	1870	1	14	24	10	3	5
Salem	1850	91	58	99	.....	16	6
	1860	42	125	138	41	9	25
	1870	16	92	1,111	102	14	22
Somers	1850	.....	.....	.....	.....	.....	.....
	1860	32	56	138	114	55	78
	1870	23	24	128	144	61	47
Southport	1850	11	25	28	2	20	3
	1860	.....	.....	.....	.....	.....	.....
	1870	.....	.....	.....	.....	.....	.....
Wheatland	1850	7	50	55	1	188	10
	1860	16	34	5	317	84	51
	1870	13	7	11	252	49	9

Note.—The figures in the above table are taken from copies of the original U. S. Census Returns, which are in the vault of the office of the Secretary of State.

TABLE 2.— *Nativity of county and towns.*

	NATIVE-BORN.			FOREIGN-BORN.		
	1850.	1860.	1870.	1850.	1860.	1870.
Kenosha county	7,381	8,500	9,068	3,437	4,444	4,057
City of Kenosha	2,338	2,437	2,987	1,201	1,328	1,292
Brighton	442	585	704	438	590	483
Bristol	986	1,072	945	139	236	194
Paris	581	640	614	375	443	397
Pike-Somers	479	805	932	201	420	423
Pleasant Prairie	546	805	913	413	433	456
Randall	.....	484	414	.....	130	115
Salem	853	1,064	1,029	270	364	356
Southport	274	.....	.....	89	.....	.....
Wheatland	882	608	530	311	500	341

Note.—The above figures were obtained by carefully going over the copy of the original manuscript of the census returns for the above years, which are in the vault of the office of the Secretary of State. The census taker neglected to give the birth of 575 in 1860, and 49 in 1870, consequently these numbers are not included in the table.

TABLE 3.— *Total Population.*

	Area in square mile.	1850	1860	1870	1880	1890	1900
Kenosha county .	268.04	10,818	13,519	13,174	13,550	15,581	21,707
City of Kenosha..	1.25	3,539	3,992	4,307	5,039	6,532	11,606
Kenosha Co., excl. city of Kenosha.	266.79	7,279	9,527	8,867	8,511	9,049	10,101
Brighton	35.7	880	1,176	1,187	1,024	926	850
Bristol	35.98	1,125	1,369	1,140	1,069	1,071	1,151
Paris	35.67	956	1,085	1,014	1,002	871	818
Pike–Somers	40.07 35.42	680	1,278	1,359	1,458	1,632	2,044
Pleasant Prairie ..	43.41 35.93	959	1,400	1,377	1,386	1,646	1,776
Randall	21.59	.....	660	533	451	658	784
Salem	30.77	1,123	1,444	1,386	1,286	1,493	1,846
Southport	12.14	363	.....	.....	.....	.....	.....
Wheatland	21.59 45.15	1,193	1,115	871	853	752	832

Note.—The above figures for population were all taken from the U. S. Census Reports. Those for 1850, 1860 and 1870 are as corrected. The area in square miles was obtained by getting the actual number of acres in the towns from the plats of the original U. S. Survey in 1835-36 and dividing by 640.

TABLE 4.—*Valuations.*

	CASH VALUE OF FARMS.			TOTAL VALUATION.		
	1850.	1860.	1870.	1850.	1860.	1870.
Kenosha Co. ...	$1,995,510	$4,494,499	$6,013,271	$1,065,956	$3,973,150	$5,047,434
City of Kenosha	.....	.....	.....	348,317	1,040,093	439,111
Brighton	148,430	360,186	706,748	85,940	316,626	596,059
Bristol	277,964	1,646,935	792,821	95,543	413,933	854,697
Paris	245,445	465,690	823,801	90,955	373,553	661,276
Pike-Somers . ..	312,637	529,521	1,060,690	100,732	538,048	873,197
Pleasant Prairie	299,990	582,492	1,094,836	100,071	479,136	516,723
Randall	.....	88,225	457,050	.....	221,156	260,864
Salem	226,092	576,370	704,344	90,615	358,457	671,553
Southport	215,805	.....	.....	60,955	.....	.....
Wheatland	269,147	245,080	373,081	92,818	232,148	173,954

Note.—Cash value of farms taken from U. S. Census Returns, and the total valuation from the Assessment File in the vault of the office of the Secretary of State.

TABLE 5.—*Occupation of Males over 15 years of age by percentage for the years 1860 and 1870.*

	Years.	Per cent. of total population.	Farmers.	Capitalists and Merchants.	Professional men.	Artisans and Mechanics.	Laborers.
Kenosha County ...	1860	38.4	33.2	1.8	2.3	7.5	25.5
	1870	30.6	37.06	2.8	2.3	8.8	31.01
City of Kenosha ...	1860	27.3	4.3	5.3	5.03	19.02	23.1
	1870	23.1	3.7	5.7	4.5	19.58	26.8
County without city	1860	32.	43.	.6	1.3	3.08	26.4
	1870	31.1	52.7	1.56	1.3	4.07	32.8
Brighton	1860	31.6	41.2	.....	1.	2.1	29.8
	1870	30.2	60.5	.3	.5	1.4	35.0
Bristol	1860	33.3	39.	.9	2.1	4.6	30.6
	1870	32.5	54.8	3.7	1.6	5.9	29.9
Paris	1860	34.2	41.8	.....	.8	2.4	34.5
	1870	35.2	58.2	.....	1.4	2.8	30.6
Pleasant Prairie ...	1860	33.8	41.2	.2	1.2	1.4	17.6
	1870	34.2	43.5	2.3	.6	3.4	37.6
Somers	1860	32.1	57.2	.7	.9	2.6	14.6
	1870	31.4	59.9	.7	1.6	3.9	27.2
Randall	1860	33.4	42.2	.....	.....	.....	26.8
	1870	19.2	17.6	.9	.9	4.9	56.9
Salem	1860	30.7	39.9	1.12	2.03	7.6	25.3
	1870	31.5	41.9	2.7	2.06	6.2	33.5
Wheatland	1860	28.6	59.7	1.5	1.25	4.4	36.2
	1870	27.9	58.9	.4	2.07	4.14	26.9

TABLE 6.— *Products.*

	Value of farm per capita.	Bushels Per Capita.				Lbs. Per Cap.	
		Wheat.	Indian corn.	Oats.	Barley.	Butter.	Cheese.
1850.							
Kenosha county without city	272.1	41.7	13.8	28.8	1.3	36.4	8.08
Kenosha county with city	184.4	28.	9.3	19.3	.8	24.5	5.43
Brighton	168.5	33.9	8.66	17.5	1.13	44.3	1.58
Bristol	246.8	39.9	14.7	21.9	1.12	41.2	10.02
Paris	256.4	43.7	12.6	30.1	.6	40.8	3.7
Pleasant Prairie	312.4	42.2	14.6	28.3	.4	42.5	12.1
Pike	460.	50.7	14.7	57.6	1.78	29 9	8.3
Salem	200.4	34.7	9.27	17 8	1.87	32.6	8.18
Southport	594.	6 52	9.35	8.76	.....	24.2	38.7
Wheatland	225.1	59.3	21.8	18.7	2.41	28.7	1.8
1860.							
Kenosha county with city	332.1	21.9	11.8	15.15	2.	24.2	2.9
Kenosha county without city	472.	31.1	16.8	21.5	2.9	34.5	4.2
Brighton	306.8	37.7	12.4	25 6	2.1	32.8	.3
Bristol	1,202.8	32.4	18.5	27.9	6.4	12.3	7.
Paris	431.8	54.5	14.3	31.9	4.8	45.7	3.09
Pleasant Prairie	416.	28.9	13.6	18.1	2.1	48.5	3.1
Randall	133.7	12.6	17.6	11.2	.2	13 5	.....
Somers	413.8	29.2	15.5	17.2	3.3	52.	10.9
Wheatland	220.	22.5	15.9	15.	.4	20.5	.7
1870.							
Kenosha county with city	516 1	15.4	23.1	24.7	36.6	35.4	22.8
Kenosha county without city	678.	22.6	34.5	36.6	48.3	52.6	34.
Brighton	591.9	38.1	34.8	26.2	3.5	75.2	4.4
Bristol	694.1	19.4	34.8	45.	9.1	56.2	27.8
Paris	811.9	40.2	29.2	40.	6.6	65.2	17.5
Pleasant Prairie	796.5	14.2	31 6	36.4	5.8	44.5	162.2
Randall	877 1	37.2	47.5	54 2	9.3	51.9	6.9
Salem	506.2	12.3	23.5	29.2	2.	40 5	11.5
Somers	782.5	14.7	20.1	40.6	4.9	50.8	1.7
Wheatland	427.5	31 4	41.6	29.1	2 2	37.1	.6
1885.							
Kenosha county with city	426.9	3.6	43.8	45.	5.9	51.4	10.5
Kenosha county without city	668.	5.7	68.4	70.	9.2	80.5	16.5
Brighton	691.	7.39	80 8	115.8	8 5	63.8	10.3
Bristol	647.	2.2	52.2	66.3	8.4	127.2	.....
Paris	672.5	7.6	49.8	111.9	17.4	66.9	.....
Pleasant Prairie	723.	7.3	45.7	54.9	6.5	126.1	5.8
Randall	752 8	12.1	131.2	105.3	22.4	53.8	163.1
Salem	714.	3.7	106.8	51.7	1.7	88.5	27.8
Somers	506.	3.9	26.7	57.3	8.4	58.4	.....
Wheatland	533 5	.47	109.8	38.7	11.5	23.9	14.5
1895.							
Kenosha county with city	423.	.523	23.85	42.1	1.6	83.4	.....
Kenosha county without city	787.2	.981	44.5	78.4	3.1	155.1	.....
Brighton	879.9	.8	108.9	145.	.9	22.2	.....
Bristol	826.	.5	41.3	65.7	2.9	230.4	.....
Paris	616.5	.2	90.8	173.9	2.3	.....	22.9
Pleasant Prairie	1,062 5	1.3	20.8	51.1	4.1	135.2	.....
Randall	971.	3.2	43.7	92.1	5.1	546.9	.....
Salem	528.9	1.0	15.4	31.4	2 7	79.2	.....
Somers	779.2	.7	28.2	63.1	4.55	151 5	.....
Wheatland	788.	1.77	96 3	81.3	3.462	.304	.....

TABLE 7.— *Occupations, 1860-1870.*

	Years.	Total population.	Farmers.	Capitalist and merchant.	Professional men.	Artisans and mechanics.	Smaller trades and profession.	Petty tradesmen.	Laborer.	Miscellaneous.
Kenosha county	1860	4,141	1,371	76	95	312	189	71	1,059	968
	1870	3,971	1,475	113	93	350	266	99	1,233	342
Kenosha city	1860	1,091	47	58	55	208	147	67	253	256
	1870	1,215	46	70	55	238	208	91	326	181
County without city	1860	3,050	1,324	18	40	104	42	4	806	712
	1870	2,756	1,429	43	38	112	58	8	907	161
Brighton	1860	372	172	.....	4	8	1	.....	111	76
	1870	357	216	1	2	5	.....	1	125	7
Bristol	1860	456	178	4	10	21	11	.. ..	140	92
	1870	371	203	14	6	22	12	.....	111	3
Paris	1860	371	155	.....	3	9	3	.....	128	58
	1870	356	207	.....	5	11	2	.....	109	18
Pleasant Prairie	1860	473	195	1	6	7	6	.....	82	176
	1870	471	205	11	3	16	12	2	177	45
Randall	1860	220	93	.....	.....	.....	2	.....	59	66
	1870	102	18	1	1	5	.....	.....	58	19
Somers	1860	411	235	3	4	11	4	1	59	94
	1870	426	255	3	7	17	7	2	116	19
Salem	1860	444	177	5	9	34	12	2	112	93
	1870	437	183	12	9	27	19	1	146	40
Wheatland	1860	318	119	5	4	14	3	1	115	57
	1870	241	142	1	5	10	6	2	65	10

Note.—The above figures were taken from the U. S. census returns, in the office of the Secretary of State.

TABLE 8.— *Population and chief products of county and towns for 1850, 1860, 1870, 1885 and 1895.*

1850.

County and town.	Total population.	Cash value of farms.	Bush. of wheat.	Bush. of Indian corn.	Bush. of oats.	Bush. of barley.	Pounds of butter.	Pounds of cheese.
Kenosha county	10,818	1,995,510	303,176	100,294	209,790	9,459	265,023	58,923
Brighton	880	148,430	29,512	7,616	15,427	974	38,980	1,390
Bristol	1,125	277,964	44,595	16,842	23,828	1,258	46,340	11,273
Paris	956	245,445	41,560	12,060	28,948	584	39,120	3,540
Pleasant Prairie	959	299,990	40,331	14,032	27,190	429	40,760	11,570
Pike	680	312,637	34,470	10,059	39,136	1,235	20,130	5,647
Salem	1,123	226,092	59,061	10,410	20,193	2,114	36,645	9,191
Southport	363	215,805	2,363	3,393	3,179	.....	8,780	14,080
Wheatland	1,193	269,147	70,284	26,082	21,889	2,865	34,266	2,250

1860.

Kenosha county	13,519	4,494,499	297,722	160,911	205,117	27,825	328,739	40,239
Brighton	1,176	360,186	44,069	14,678	30,092	2,474	38,608	365
Bristol	1,369	1,646,935	44,346	25,341	38,257	8,835	16,882	9,555
Paris	1,085	465,630	58,159	15,553	34,416	5,295	49,600	3,355
Pleasant Prairie	1,400	582,492	40,454	19,056	25,358	2,953	67,779	4,352
Randall	660	88,225	8,359	11,644	7,394	145	8,930	.....
Salem	1,441	576,370	39,883	37,108	30,831	3,378	57,547	7,350
Somers	1,278	529,521	37,335	19,779	21,979	4,275	66,427	13,962
Wheatland	1,115	245,080	25,111	17,752	16,790	475	22,965	792

1870.

Kenosha county	13,174	6,013,271	205,732	270,919	325,246	45,870	466,407	300,517
Brighton	1,157	706,748	41,751	38,207	31,185	4,204	89,005	5,200
Bristol	1,140	792,821	22,109	29,712	51,494	10,422	64,099	31,730
Paris	1,014	823,801	40,849	29,610	40,634	6,774	66,452	17,830
Pleasant Prairie	1,377	1,094,836	19,506	43,600	50,526	8,069	61,520	223,065
Randall	534	457,050	16,971	25,360	28,997	4,972	27,785	3,725
Salem	1,386	704,344	17,117	32,618	40,719	2,778	56,190	16,025
Somers	1,359	1,060,690	19,923	27,346	26,250	6,721	69,008	2,385
Wheatland	871	373,081	27,506	38,366	25,391	1,931	32,350	557

1885.

Kenosha county	14,137	6,032,904	52,179	618,036	632,404	83,125	726,096	149,572
Brighton	961	884,780	7,118	77,793	111,195	8,242	61,460	9,920
Bristol	1,134	734,240	2,515	59,215	75,215	9,598	144,115	.....
Paris	991	685,405	7,543	49,370	110,952	17,284	66,365	.....
Pleasant Prairie	1,494	1,078,350	10,906	68,102	82,236	9,775	188,650	6,800
Randall	489	367,879	5,910	64,211	51,552	10,964	26,281	79,812
Salem	1,282	985,050	5,203	147,340	71,488	2,295	122,365	38,540
Somers	1,590	805,000	6,299	42,445	91,130	13,437	92,960	.....
Wheatland	999	532,200	478	109,560	38,640	11,550	23,900	14,500

1895.

Kenosha county	17,548	7,416,013	9,241	418,815	738,658	29,403	1,460,850	17,900
Brighton	878	763,143	773	95,550	127,190	883	19,550	.....
Bristol	1,143	946,650	552	47,495	75,255	3,321	265,187	.....
Paris	883	544,275	240	80,050	153,556	2,040	.....	17,900
Pleasant Prairie	1,524	1,617,900	1,992	30,800	77,825	6,289	206,450	.....
Randall	643	621,500	2,112	28,075	59,290	5,218	351,850	.....
Salem	1,887	998,605	1,139	23,360	78,210	1,165	149,040	.....
Somers	1,819	1,410,360	1,284	51,050	114,607	8,262	191,293	.....
Wheatland	649	510,810	1,149	62,815	52,785	2,245	277,280	.....

NOTE.—The above figures for 1850, 1860, and 1870 were taken from the United States census returns, which are in the office of the Secretary of State, and the rest from the state census reports.

TABLE 9.— *Summary and percentage of Republican and Democratic votes for president, governor, and congressman.*

	PRESIDENT, 1860-1900.				GOVERNOR, 1859-1900.				CONGRESSMAN, 1866-1900.			
	Republican.		Democratic.		Republican.		Democratic.		Republican.		Democratic.	
	Vote.	Per cent. of total.	Vote.	Per cent. of total.	Vote.	Per cent. of total.	Vote.	Per cent. of total.	Vote.	Per cent. of total.	Vote.	Per cent. of total.
Kenosha county ..	20,101	56	15,900	44	27,943	53	24,510	47	19,488	55	19,942	45
Kenosha city	7,100	52	7,080	48	10,387	48	11,268	52	7,701	52	7,645	48
Brighton..	869	35	1,584	65	1,203	34	2,288	66	791	31	1,349	69
Bristol....	2,139	76	678	24	3,150	75	1,030	25	1,984	75	652	25
Paris.....	1,169	51	1,122	49	1,558	48	1,703	52	1,013	48	1,085	52
Pleasant Prairie..	2,107	58	1,503	42	3,068	58	2,174	42	1,960	59	1,358	41
Randall...	1,023	67	491	33	1,409	66	711	34	895	64	497	36
Salem.....	2,446	68	1,233	32	3,617	66	1,855	34	2,248	65	1,227	35
Somers ...	2,441	69	1,077	31	3,386	68	1,540	32	2,184	68	1,045	32
Wheatland	805	41	1,157	59	1,160	38	1,843	62	712	39	1,084	61

ECONOMIC AND SOCIAL DEVELOPMENT OF LA FAYETTE COUNTY BETWEEN 1850 AND 1870.[1]

KATHERINE PATRICIA REGAN.

Chapter I.

FORMATION OF THE COUNTY AND TOWNS.

La Fayette county, situated in the southwestern part of Wisconsin, was originally a part of Iowa county. But the discovery of the lead mines about 1820 resulted in so great an increase of population that in 1847 it was found necessary to divide Iowa county, the southern part of which containing the lead mines of the Wisconsin district was designated as La Fayette county.

The class of people attracted by mining interests, however, made no permanent settlements. They were of too migratory a nature, moving here and there as their interests directed them. And though there was a considerable scattered population soon after 1822, no permanent settlement was made before 1826. It is doubtful whether any would have been made even then, had not the inhabitants found it necessary to build a fort at Gratiot's Grove for protection against the Indians.

Certain lands north of what is known as the Ridge[2] had been reserved for the Indians. But finding that these contained rich lead deposits, miners constantly crossed the line in utter disregard for any rights the Indians might have. Repeated protests on the part of the Indians resulting in no redress of their grievances, the matter finally concluded in the uprising commonly

[1] A thesis submitted to the faculty of the University of Wisconsin for the degree B. L., June, 1901.

[2] The Ridge is two miles north of the village of Shullsburg.

known as the Winnebago war. Then it was that the fort known as Gratiot's Fort was built, and the first permanent settlement started. The prompt action of Governor Edwards of Illinois quelled the disturbance, however, and the fort was never used as such. This defeat had the effect of quieting the Indians, and the valuable lands held by them were thereafter open to settlement.[1]

The legal boundaries of La Fayette county are as follows: "That part of the county embraced in Iowa county designated as towns 1, 2, 3, 4 and 5 east, and the south half of town 4, ranges 1, 2, 3, 4, and 5, shall be set off into a separate county named La Fayette."[2] It was organized for judicial purposes after May 1, 1847.

Before its organization into towns La Fayette county consisted of five election districts,—Kendall, Willow Springs, Argyle, Gratiot and the Fever River district. On January 3, 1849, from the Kendall district the towns of Belmont and Kendall were organized; from Willow Springs district, Darlington (Centre) and Willow Springs; from Argyle, Fayette, Argyle and Wiota; from Gratiot, Wayne[3] and Gratiot; from the Fever River district, Benton, New Diggings, Elk Grove, Shullsburg, White Oak Springs and Monticello. Blanchard was organized out of the northern part of the town of Argyle, and Seymour from Centre, in 1869.[4]

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[1] The above was taken from the History of La Fayette County, Wisconsin, 1881, and the Geography and Gazeteer of Wisconsin.

[2] These boundaries are copied from the thesis of B. M. Palmer, "The Lead Regions of Illinois." They became the legal boundaries Feb. 14, 1847. Session Laws of Wisconsin Territory for 1847, p. 57.

[3] Wayne is known as the "lost township" as the original survey of that town was lost on its way to the United States land office. In 1835 it was re-surveyed.

[4] See Plate XLIII.

Chapter II.

TOPOGRAPHY AND SOILS.

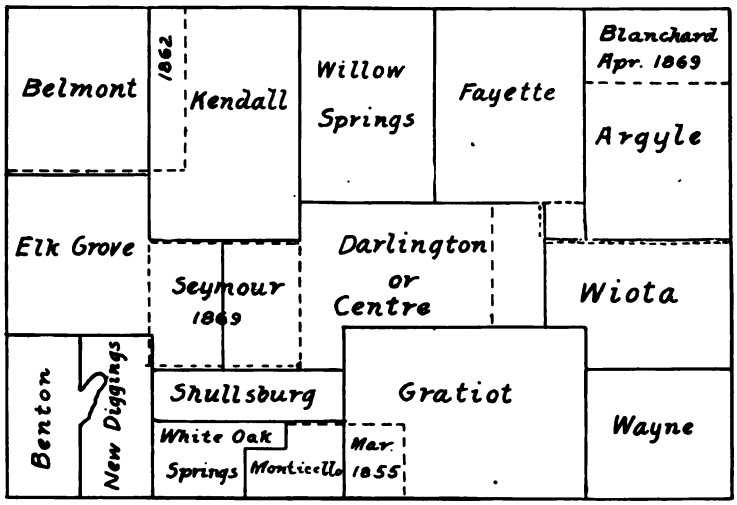
Before taking up a discussion of the population of this county, it will be necessary to state something of its geology:[1] The county forms part of the great watershed passing from Madison to the confluence of the Wisconsin and Mississippi rivers. The western branch of this watershed separates the rivers that flow into the Fever river from those that flow into the Pecatonica. Entering at the town of Belmont, it passes through Shullsburg in a southeasterly direction, leaving the county through Monticello. The highest point on this divide is the Platte Mounds, in the northern part of Belmont.

La Fayette is well watered by the Pecatonica, East Pecatonica and Fever rivers and their branches. Springs also abound, especially in the towns of Willow Springs, Centre, Wiota, White Oak Springs, Shullsburg, Benton and New Diggings. They are scarce on the prairie lands of Kendall, Belmont, Elk Grove, Wayne, Gratiot and Monticello.[2]

The soil is well adapted to agricultural purposes and unusually large successive wheat crops have been raised with no regard to rotation. A belt of rich, black loam extends through the western and central parts, including the greater parts of Seymour, Shullsburg, Darlington, Gratiot, White Oak Springs and Monticello; also large parts of Elk Grove and Belmont. There is also a much narrower belt passing through the west-central part of Fayette, which, curving through the west-central parts of Wiota, enters the southern part of Argyle. The subsoil is clay underlaid with limestone, which forms in ridges along the larger streams, affording some valuable quarries. Sand is found in the eastern part to some extent and along the rivers.[3]

[1] Geology of Wisconsin, vol. II, part IV, 1873–1877.
[2] Taken from the United States Census for 1850, manuscript records, in the office of the Secretary of State.
[3] See Plate XLIII.

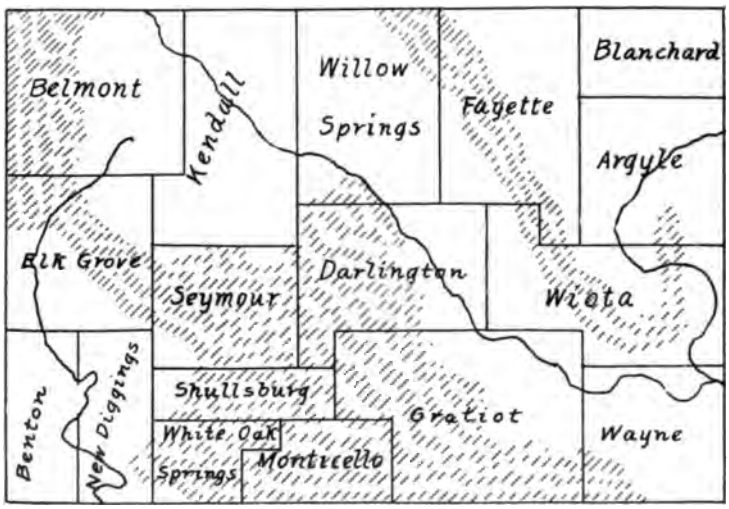
BOUNDARY CHANGES



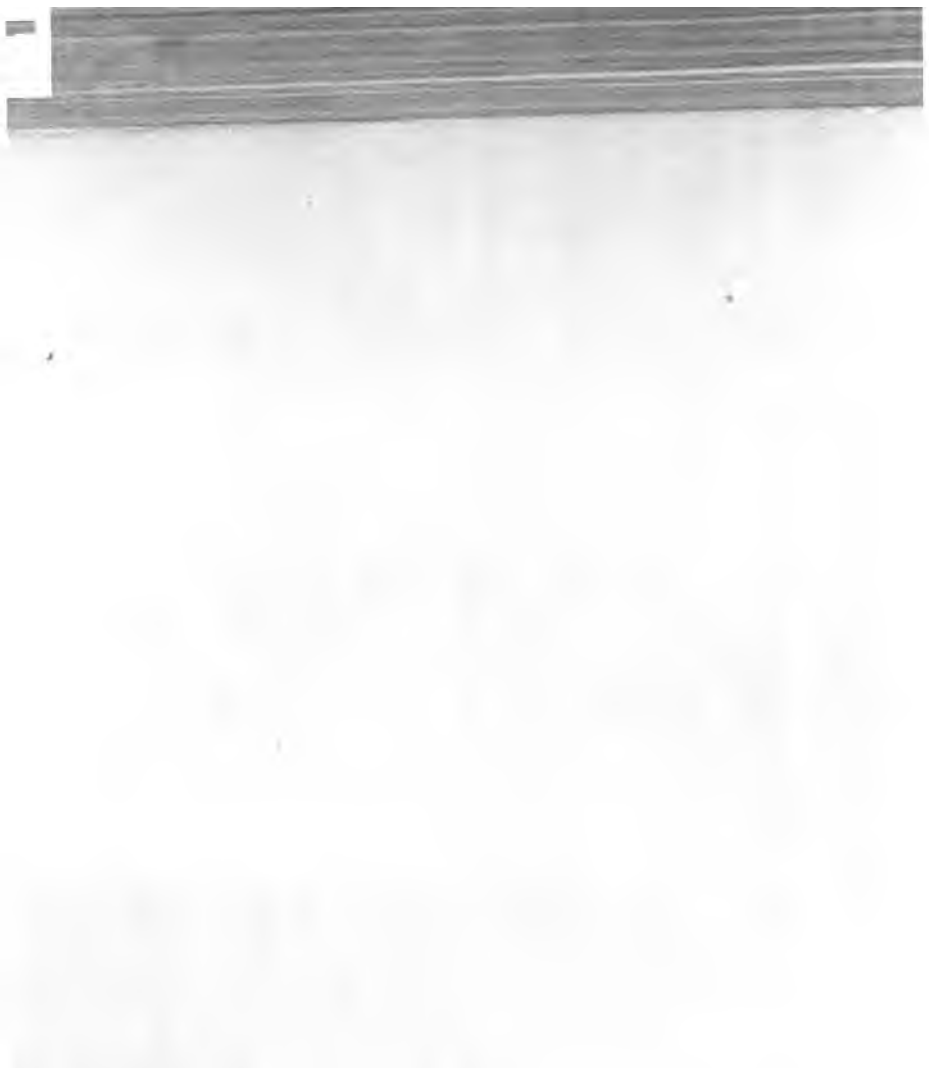
—— Original Boundaries 1847

---- Principal Changes in Boundaries Since 1847

DISTRIBUTION OF SOILS



▨ Prairie Soil ☐ Clay Soil



Chapter III.

POPULATION.

A study of the population was made by taking the nativity and occupations of all inhabitants of the county from the census of the United States for 1850, 1860 and 1870.[1] The population was then considered as divided into two parts, the native and foreign born.[2] The native born were again grouped into sections, namely, New England, Middle States, Southern States, Southwestern States, Northwestern States and Western States. Wisconsin is given in the table separately. Under the heading, Western States, are included all the states not mentioned in the other sections.

In the foreign countries the following groups were made: British America, Great Britain, the rest of Europe[3] and miscellaneous. Under the latter were grouped such as were born at sea, on the lakes, in the United States and the like.

Tables were made of the population of each section by nativities for the various towns. Comparisons can be made between the census for 1850, 1860 and 1870, for such towns only as did not change their boundary lines. These towns are Benton, New Diggings, Shullsburg, Wayne, White Oak Springs and Willow Springs.

By examining Table 1 in the Appendix it will be seen that in native population Wisconsin leads for the entire period considered, that is, from 1850 to 1870; so it will not be considered in the present comparison. Next to Wisconsin are the Northwestern States, the towns of Belmont, Wayne, Fayette, Centre, and Argyle leading. The Middle States are next, but with a percentage almost one-third less. The number from New York

[1] United States Census, manuscript records, office of Secretary of State.
[2] Those who were born in any part of the United States were considered native born,—the rest, foreign born.
[3] This division includes the countries not comprised in the other groups of foreign countries.

alone differs but slightly from that of the remainder of the section of Middle States. In this Middle section the town of Fayette contains about one-fifth of the entire number represented by both the Middle and Northwestern sections. The New England and Southern sections are represented about equally. In New England settlers Centre, Willow Springs, Wayne, Fayette and Argyle are in the lead. In the Southern section the towns of Monticello, White Oak Springs, Kendall, Fayette and Belmont have the largest number.

In the foreign population Great Britain stands first, with Ireland second; together these sections constitute nearly one-half of the entire foreign population of the county. Under Great Britain, Benton leads, with Elk Grove, New Diggings, White Oak Springs and Shullsburg closely following. These are the towns, it will be remembered, that constitute the mining district.[1] Ireland is represented chiefly in this district, also in New Diggings, Shullsburg, Benton, and Willow Springs and Kendall. The rest of the foreign population altogether constitutes about five per cent. of the entire foreign population. It is thus seen that the mining districts contain the greatest foreign population in 1850.

In 1860 the towns showing the highest percentage of population from the Northwestern section are Belmont, Fayette, Monticello, Gratiot and Wiota.[2] New York in this census is represented by a greater percentage than the rest of the Middle States. Centre, Gratiot, Wayne, Argyle, Wiota and Kendall, the last two being equal, lead in population from this state. The rest of the Middle section is most largely represented in Monticello, Fayette, Wiota, Belmont and Gratiot.

In the foreign population Ireland leads Great Britain, but has decreased slightly since 1850, though the decrease in the percentage of Great Britain has been twice as great. The towns having the highest percentage of Irish are New Diggings, Kendall, Shullsburg, Willow Springs and Benton. These are the

[1] For further information on this subject see: Thesis of F. Belle Stanton, Lead Regions of Wisconsin, Univ. of Wis., 1901; Libby, An Economic and Social Study of Lead Regions in Iowa, Illinois and Wisconsin; Thwaites, Early Lead Mining in Illinois and Wisconsin.

[2] See Appendix, Table 2.

same towns which showed the highest percentage of Irish in 1850.[1]

The towns having the highest percentage of population from Great Britain are Benton, White Oak Springs, New Diggings, Elk Grove and Shullsburg. These towns also lead in 1850.[2] The percentage from Great Britain and Ireland is more than twice as great as the percentages of the combined population of the rest of the foreign countries.

In 1870 the Northwestern States still have the greatest percentage of population, with the towns of Wayne, Monticello, Gratiot, Benton and White Oak Springs leading.[3] The percentage of New York differs but slightly from that of the remainder of the Middle States, but both have decreased since 1860. New England and the South are about equally represented.

In the foreign population the percentages of Great Britain and Ireland are almost equal. The towns with the largest Irish population in 1870 are Kendall, Seymour, New Diggings, Shullsburg and Benton, the last three of which held the same relative position in 1860. The towns having the largest population born in Great Britain are New Diggings, Benton, White Oak Springs, Willow Springs and Seymour, three of which, New Diggings, Benton and White Oak Springs, had the greatest population from the same country in 1860.

To summarize:—The Wisconsin-born population has the largest number, and the Northwestern States stand next in all three censuses. New York has a greater population than any state in the East during the whole period. In 1850 the New England and Southern sections are about equal; in 1860, New England has not changed, but the South has decreased slightly; in 1870 they are again about equal.

In the foreign population in 1850, Great Britain leads with Ireland second; in 1860, Ireland exceeds Great Britain, but the population from both these countries has decreased. In 1870

[1] Kendall must be omitted in this comparison as its boundary line had been changed between 1850 and 1860.

[2] Except Elk Grove, whose boundary line was changed between 1850 and 1860.

[3] See Appendix, Table 3.

Great Britain and Ireland are about equal. It was shown that the percentage of population of these two countries taken together was greater than the percentages of population of the rest of the foreign countries. The percentage of German population greately increased between 1850 and 1860.

TABLE 1.— *Percentages of native and foreign born population.*

	1850.		1860.		1870.	
	Native.	Foreign.	Native.	Foreign.	Native.	Foreign.
Argyle	72	28	66	34	64	36
Belmont	86	14	77	23	68	32
Benton	39	61	52	48	61	79
Blanchard	..	..	..	..	60	40
Darlington	78	22	76	24	80	20
Elk Grove	57	43	56	44	65	35
Fayette	85	15	79	21	76	24
Gratiot	79	21	82	18	78	22
Kendall	78	22	66	34	67	33
Monticello	64	36	71	29	76	24
New Diggings	43	57	53	47	62	38
Seymour	..	..	..	..	55	45
Shullsburg	52	48	57	43	65	35
Wayne	92	8	92	8	88	12
White Oak Springs	64	36	66	34	71	29
Willow Springs	69	31	66	34	70	30
Wiota	74	26	71	29	72	28
Average for county	60	40	66	34	70	30

In Table 1 the percentages of the entire native and foreign born for each town and for each census are given. In 1850 the percentage of native born population for the entire country was 60; of the foreign born population, 40. By 1870, the native born population had increased to 70 per cent.; the foreign born had decreased to 30 per cent.

Of the towns whose boundaries did not change, Benton had 39 per cent. native born in 1850, and 61 per cent. in 1870, a gain of 22 per cent. Of foreign born population, Benton had 61 per cent. in 1850, and 39 per cent. in 1870. New Dig-

gings in 1850 had a native born population of 43 per cent.; in 1870, 62 per cent., a gain of 9 per cent., while the foreign born population decreased from 57 per cent. in 1850 to 38 per cent. in 1870. The towns of Shullsburg, Wayne and White Oak Springs show a similar increase in the native born population and decrease in the foreign. Willow Springs, however, in 1850 had a native born population of 69 per cent.; in 1860, of 66 per cent., and in 1870 of 70 per cent., showing a total increase between 1850 and 1870, of 1 per cent. In 1850, Willow Springs had 5 per cent. more native born population than White Oak Springs, but in 1860 the percentages of both are the same. In 1870 White Oak Springs had increased 1 per cent. over Willow Springs.

Chapter IV.

DENSITY, WEALTH AND OCCUPATION.

Table 2.— *Per capita wealth, and population per square mile.*

Towns.	Years.	Nativity.		Property.		Population per square mile.
		Native.	Foreign.	Person'l.	Real estate.	
Benton	1850	39	61	1	34	81
	1860	52	48	11	62	76
	1870	61	39	32	168	62
New Diggings	1850	43	57	6	46	65
	1860	53	47	20	71	63
	1870	62	38	33	155	68
Shullsburg	1850	52	48	10	66	47
	1860	57	43	45	79	69
	1870	65	35	64	217	73
Wayne	1850	92	8	13	65	9
	1860	92	8	40	216	18
	1870	88	12	53	143	29
White Oak Springs	1850	64	36	78	107	28
	1860	66	34	25	146	32
	1870	71	29	73	282	33
Willow Springs	1850	69	31	7	114	12
	1860	66	34	49	238	17
	1870	70	30	79	232	23

In Table 2 is given the per capita of real estate and personal property and the native and foreign born populations with the population per square mile for six towns of fixed boundaries.[1] In this comparison the native born population increases in every town except Wayne, where a slight decrease is noted between 1860 and 1870. But this town also shows a less increase per capita for that period than any other town. Between 1860 and 1870 the population per square mile is doubled, the native and foreign born retaining the same percentage as in 1850, while the per capita is more than trebled. A greater increase in the per capita is shown in the towns where the native population increases. This may be shown more clearly, perhaps, by a comparison between the mining towns and farming towns of this table: New Diggings and Shullsburg composing the first

TABLE 3.— *Percentages of increase and decrease of density in population.*

	INCREASE, PER CENT.	DECREASE, PER CENT.	POPULATION PER SQUARE MILE.	
	1850.	1870.	1850.	1870.
Benton	.....	29	81	62
New Diggings	3	.....	66	68
Shullsburg	61	.....	47	73
Wayne	214	.....	9	29
White Oak Springs	19	.....	28	33
Willow Springs	81	.....	12	23

class of towns and Wayne, White Oak Springs and Willow Springs, the second class. The per capita of the real estate and personal combined in the mining towns for the whole period between 1850 and 1870 is $64, while a similar per capita of the farming towns is $224. But the area of the latter class of towns is one-tenth greater than that of the former; this would leave the per capita of the towns of the farming class about

[1] In computing the population per square mile, some difficulties arose because of the changes in town boundary lines, the county history being inaccurate in this respect. After a comparison of the Plat book for 1895, an atlas for 1847 and various maps found in the office of the Secretary of State and the map room of the Historical Library, the areas given in Table 5 in the Appendix were decided upon as being approximately correct.

$200. This is the more striking when we remember that White Oak Springs, classed with the farming towns, had large mining interests in an earlier period. We may thus see that although mining as a factor in the industrial life of the county had almost disappeared, its influence upon the economic life of the towns considered is still marked.

In comparing the percentages of increase and decrease between 1850 and 1870 of these same towns, in Table 3 we find Wayne increasing 214 per cent. and from 9 to 29 per square mile. White Oak Springs increases 19 per cent. and from 28 to 33 per square mile. The greatest increase in the first class is in Shullsburg, with 61 per cent., and from 47 to 73 per square per square mile.

TABLE 4.— *Percentage of principal occupations.*

	FARMERS.			MINERS.			LABORERS.		
	1850.	1860.	1870.	1850.	1860.	1870.	1850.	1860.	1870.
Argyle	65.3	62	38.3	18.2	.....	3.2	5.7	26	41
Belmont	84.8	72.4	30.8	3	.....	.43	1.5	18	51.9
Benton	8.5	30	23.1	77.2	50.5	37.7	1.6	7.2	28.4
Blanchard	.....	.....	42.9	.....	.....	2.4	.....	.....	39.6
Darlington, town	.....	.....	55.8	.....	.....	.....	.....	.....	38.6
Darlington, town & village	76.6	56	.....	7.8	.2	.....	.6	18	.....
Darlington village	.....	.....	9.8	.....	.....	.5	.....	.....	33.7
Elk Grove	73.6	69	43.8	11.1	5	1.1	3.5	17	47.8
Fayette	74	71	55	15.8	.....	1.8	1	24	35
Gratiot	80	65	39.4	3	.....	.....	1.5	29	40.8
Kendall	84	78	50.1	.....	3	.31	2.2	15.8	48
Monticello	52.9	48.8	42.7	2.9	3.8	.....	.....	41	52.6
New Diggings	7.5	16.2	70.5	73	50.4	47.6	2.2	21	26
Seymour	.....	.....	34.4	.....	.....	.....	.....	.....	43
Shullsburg	12.3	24	23.4	61	35	32.2	4.5	15	25.8
Wayne	87.3	59.7	50	1.2	.....	.....	1.2	21	48
White Oak Springs	53	38.4	44.9	21	13	3.5	2	54.7	47.3
Willow Springs	76.4	21.7	60.9	13.7	.....	.99	3.3	55.4	29
Wiota	63	63	41.2	7.3	.....	1.9	3.7	31.5	52

The mining class was kept separate since the southwestern part of the county is a mining district. Farmers, miners and laborers have the largest percentage. Table 4 shows the rela-

tive importance of these occupations in the census of 1850, 1860 and 1870.

The percentage of farmers seems to have greatly decreased between 1850 and 1870, but a fair estimate cannot be made since in the census of 1850 no distinction is made between farmers and farm laborers; that is, all are classed as farmers, irrespective of property. In the census of 1860 and 1870 this distinction is made. This fact will also explain, at least in part, the large increase in the laboring class between 1860 and 1870. In comparing the towns whose boundary lines remain fixed, we find that the percentage of farmers has increased in Benton, New Diggings and Shullsburg between 1850 and 1870, despite the fact that farm laborers are included in 1850. The percentage of artisans is but 1.9 less than the percentage of farmers in 1850, while in 1870 the latter has increased 20.6 per cent. The mining class, on the contrary, has decreased. Wayne shows a decrease in the farming class and the mining class disappears after 1860, but the laboring class increases 41.8 per cent. White Oak Springs and Willow Springs show so slight a decrease between 1850 and 1870 in the farming class that we may conclude that had the census tabulations been made upon the same basis in all three censuses, an increase would have been shown. Mining declines in both these towns and the laboring class increases.

We see from the foregoing that La Fayette county is distinctly an agricultural region, though that particular industry would seem to be on the decline. We should note that in the towns of the mining district mining has given place to farming, but the influence of the former occupation is shown in the lower per capita of these towns.[1] The constant shifting of the boundary lines of the various towns makes comparisons between all of the towns impossible for the different census periods, and hence the study has not been as extensive as we would like. It has been possible to compare an equal number of towns of the farming and mining regions, however, and these may be considered typical for the entire county.

[1] See Table 2.

APPENDIX.

Tables 1-5.

Showing Nativity of population of each town in La Fayette county for 1850, 1860 and 1870. Taken from copies of the original Census Returns in the office of the Secretary of State.

TABLE 1.

1850.	NEW ENGLAND STATES.							MIDDLE STATES.				
	Connecticut.	Maine.	Rhode Island.	Vermont.	New Hampshire.	Massachusetts.	Total.	New York.	New Jersey.	Pennsylvania.	Delaware.	Total.
Argyle	9	5	1	5	1	4	25	31	1	40	.....	72
Belmont	3	2	3	3	2	.....	13	19	1	22	.....	42
Benton	7	4	.....	3	3	5	22	40	22	38	.....	100
Centre	4	5	2	32	6	6	55	58	7	49	1	115
Elk Grove	3	.....	.....	2	.....	2	7	37	2	28	1	68
Fayette	8	9	.....	16	7	9	49	35	5	93	1	134
Gratiot	1	2	3	8	1	9	24	83	.....	64	.....	147
Kendall	.....	2	.....	1	2	.....	5	38	.....	59	1	98
Monticello	1	.....	1	1	3	2	8	11	1	15	.....	27
New Diggings	4	7	.....	6	4	21	42	44	7	59	.....	110
Shullsburg	6	8	.....	19	6	11	50	58	10	61	.....	129
Wayne	6	1	.....	3	11	1	22	26	2	26	.....	54
Willow Springs	8	.....	.....	10	.....	9	27	39	3	53	.....	95
White Oak Springs	3	4	.....	3	4	9	23	37	2	12	.....	51
Wiota	4	5	1	11	1	10	32	60	4	52	2	118
Total	67	54	11	123	51	98	404	616	67	671	6	1,360

TABLE 1.— Continued.

1850.	SOUTHERN STATES.									SOUTHWESTERN STATES.			
	Alabama.	Georgia.	Maryland.	North Carolina.	South Carolina.	Virginia.	Kentucky.	Tennessee.	Total.	Missouri.	Arkansas.	Louisiana.	Total.
Argyle	.....	1	1	4	.....	3	12	1	22	2	.....	.....	2
Belmont	.....	1	3	3	.....	4	14	7	32	8	.....	.....	8
Benton	1	4	4	4	.....	15	38	7	73	55	.....	1	56
Centre	.....	.....	3	2	1	8	33	6	53	2	.....	.....	2
Elk Grove	.....	.....	2	2	.....	11	8	1	24	11	1	.....	12
Fayette	.....	.....	5	7	.....	13	11	22	58	7	.....	.....	7
Gratiot	.....	3	6	1	1	3	1	2	17	2	.....	.....	2
Kendall	.....	.....	1	3	.....	10	9	2	25	3	.....	.....	3
Monticello	.....	.....	.....	1	.....	9	3	.....	13	6	.....	.....	6
New Diggings	.....	1	4	6	2	10	21	16	60	27	.....	2	29
Shullsburg	2	3	16	2	1	19	24	10	77	50	1	1	52
Wayne	.....	2	.....	2	1	6	4	13	28	4	.....	.....	4
Willow Springs	.....	.....	1	1	.....	7	13	1	23	14	.....	.....	14
White Oak Spr.	.....	.....	3	3	2	14	6	6	34	7	.....	.....	7
Wiota	.....	1	1	4	.....	14	10	10	40	1	.....	.....	1
Total	3	16	50	45	8	146	207	104	579	199	2	4	205

TABLE 1.— Continued.

1850.	NORTHWESTERN STATES.							Wisconsin.	Miscellaneous.
	Illinois.	Indiana.	Iowa.	Michigan.	Minnesota.	Ohio.	Total.		
Argyle	30	6	.....	.....	.....	58	94	90	.....
Belmont	50	2	3	.....	.....	29	84	99	.....
Benton	84	11	7	5	.....	21	128	487	4
Centre	40	14	2	.....	.....	62	118	127	2
Elk Grove	53	.....	3	.....	.....	28	84	163	3
Fayette	88	17	5	.....	.....	80	190	205	1
Gratiot	52	5	1	3	.....	40	101	107	.....
Kendall	19	13	7	.....	.....	9	48	81	.....
Monticello	11	1	1	.....	.....	5	18	55	.....
New Diggings	80	6	8	.....	1	16	111	393	6
Shullsburg	79	13	13	6	2	48	161	407	2
Wayne	30	4	2	.....	.....	49	85	116	.....
Willow Springs	25	16	.....	4	.....	49	94	171	.....
White Oak Springs	45	21	.....	3	.....	8	77	97	1
Wiota	57	16	.....	1	.....	46	120	224	5
Total	743	145	52	22	3	548	1,513	2,822	24

TABLE 1.—Continued.

1850.	BRITISH AMERICA.					GREAT BRITAIN.						
	Canada.	New Brunswick.	New Foundland.	Nova Scotia.	Total.	England.	Ireland.	Scotland.	Wales.	Orkney Islands.	Isle of Man.	Total.
Argle	4	.....	.....	.....	4	11	10	12	.....	.....	.....	33
Belmont	.....	.....	.....	.....	.....	10	29	.....	5	.....	.....	44
Benton	17	.....	.....	.....	17	707	478	19	1	.....	.....	1,205
Centre	10	.....	.....	.....	10	52	41	.....	7	.....	.....	100
Elk Grove	5	9	.....	2	16	152	62	14	1	1	.....	230
Fayette	15	.....	.....	.....	15	40	32	2	.....	.....	1	75
Gratiot	16	.....	1	.....	17	60	27	5	.....	.....	.....	92
Kendall	7	.....	.....	.....	7	21	37	2	.....	.....	.....	60
Monticello	29	.....	.....	.....	29	17	13	1	.....	.....	.....	31
New Diggings	7	.....	.....	2	9	449	499	12	.....	.....	.....	960
Shullsburg	22	2	.....	.....	24	330	387	12	1	.....	1	731
Wayne	3	.....	.....	.....	3	4	.....	.....	.....	.....	.....	4
Willow Springs	2	.....	.....	3	5	44	119	6	1	.....	.....	170
White Oak Springs	7	.....	.....	.....	7	112	34	1	.....	.....	.....	147
Wiota	5	.....	.....	.....	5	7	76	1	.....	.....	7	91
Total	149	11	1	7	168	2,016	1,844	86	17	1	9	3,973

TABLE 1.— Continued.

1850.	REST OF EUROPE.									Selkirk Settlement.
	Denmark.	France.	Germany.	Holland.	Italy.	Norway.	Spain.	Switzerland.	Total.	
Argyle	.....	.....	2	.....	.....	.....	77	.....	79	.....
Belmont	.....	.....	.....	.....	.....	.....	.....	3	3	.....
Benton	1	13	110	1	1	3	.....	2	131	.....
Centre	.....	3	10	.....	.....	1	.....	3	17	2
Elk Grove	.....	.....	16	.....	.....	.....	.....	.....	16	.....
Fayette	.....	.....	12	.....	.....	6	.....	.....	18	.....
Gratiot	.....	.....	2	.....	.....	8	.....	2	12	.....
Kendall	.....	.....	4	.....	.....	1	1	.....	6	.....
Monticello	.....	.....	7	.....	.....	.....	.....	4	11	.....
New Diggings	.....	5	14	.....	.....	2	.....	.....	21	.....
Shullsburg	.....	7	25	.....	.....	2	.....	6	40	.....
Wayne	.....	.....	.....	.....	.....	18	.....	.....	18	.....
Willow Springs	.....	.....	10	.....	.....	.....	.....	6	16	.....
White Oak Springs	.....	1	4	.....	.....	4	.....	.....	9	.....
Wiota	.....	.....	.....	.....	.....	86	.....	1	87	.....
Total	1	29	216	1	1	208	1	27	484	2

TABLE 2.

1860.	NEW ENGLAND STATES.							MIDDLE STATES.				
	Connecticut.	Massachusetts.	Maine.	New Hampshire.	Rhode Island.	Vermont.	Total.	New York.	New Jersey.	Pennsylvania.	Delaware.	Total.
Argyle	14	7	10	9	2	7	49	109	.....	71	.....	180
Belmont	6	2	4	1	1	11	25	27	4	58	.....	89
Benton	3	5	4	.....	.....	1	13	23	15	19	.....	57
Centre (Darlington)	42	50	10	17	2	55	176	337	24	89	.....	450
Elk Grove	7	2	.....	2	.....	3	14	65	9	59	2	135
Fayette	9	6	5	6	1	23	50	48	7	94	2	151
Gratiot	13	13	.....	1	1	6	34	152	3	70	.....	225
Kendall	2	7	2	4	.....	5	20	80	3	73	1	157
Monticello	2	.....	.....	.....	.....	1	3	23	2	54	.....	79
New Diggings	.....	26	3	4	12	9	54	38	6	25	.....	69
Shullsburg	4	22	2	12	.....	14	54	91	8	50	.....	149
Wayne	8	9	38	27	2	13	97	70	11	29	.....	110
Willow Springs	.....	13	.....	1	.....	7	21	36	5	30	.....	71
White Oak Springs	2	4	11	1	.....	.....	18	28	2	10	.....	40
Wiota	4	10	3	3	.....	5	25	84	.....	115	.....	199
Total	116	176	92	88	21	160	653	1,211	99	846	5	2,161

Table 2.— Continued.

1860.	Southern States.											Southwestern States.			
	Kentucky.	North Carolina.	South Carolina.	Georgia.	Maryland.	Virginia.	Louisiana.	Mississippi.	Tennessee.	Alabama.	Total.	Missouri.	Arkansas.	Texas.	Total.
Argyle	1	....	....	....	....	....	....	....	3	....	4	3	....	....	3
Belmont	10	6	1	2	1	7	....	....	10	....	37	5	....	1	6
Benton	5	3	....	2	4	9	....	....	5	....	28	23	....	....	23
Centre (Darlington)	54	2	....	....	2	7	1	....	3	2	71	5	....	....	5
Elk Grove	5	....	....	....	5	9	....	....	2	....	21	9	....	....	9
Fayette	10	2	....	....	3	3	....	....	15	....	33	1	....	....	1
Gratiot	5	8	1	....	2	18	1	....	....	....	35	3	1	....	4
Kendall	11	....	....	....	....	6	1	....	1	....	19	4	....	....	4
Monticello	1	....	....	2	4	3	....	....	3	....	13	3	....	....	3
New Diggings	13	....	....	....	....	5	....	....	3	1	22	16	2	....	18
Shullsburg	22	1	....	....	18	15	3	....	1	....	60	34	....	....	34
Wayne	4	1	....	....	....	7	....	....	5	....	17	3	....	....	3
Willow Springs	12	....	....	....	....	1	....	1	2	....	16	2	....	....	2
White Oak Springs	1	3	1	....	5	3	1	....	3	....	17	1	....	....	1
Wiota	10	3	....	....	3	6	....	....	7	1	30	1	....	....	1
Total	164	29	3	6	47	99	7	1	63	4	423	113	3	1	117

TABLE 2.— Continued.

1860.	NORTHWESTERN STATES.							WISCONSIN.	MISCELLANEOUS.			
	Illinois.	Indiana.	Iowa.	Michigan.	Minnesota.	Ohio.	Total.		District of Columbia.	California.	On Lakes.	Total.
Argyle	26	8	1	5	.....	60	100	378	.....	.....	.....	.....
Belmont	77	2	3	1	.....	57	140	269	.....	.....	.....	.....
Benton	50	6	2	.....	.....	18	76	890	.....	.....	1	1
Centre (Darlington)	59	9	5	14	.....	107	194	576	.....	.....	1	1
Elk Grove	44	5	3	.....	.....	25	77	484	.....	.....	.....	.....
Fayette	39	17	2	1	.....	89	148	398	.....	.....	.....	.....
Gratiot	59	18	7	6	.....	57	147	379	.....	.....	.....	.....
Kendall	36	11	2	.....	1	62	112	432	.....	1	.....	1
Monticello	39	4	.....	1	.....	28	72	157	.....	.....	.....	.....
New Diggings	21	1	.....	2	1	9	34	691	3	.....	.....	3
Shullsburg	90	18	11	6	1	29	155	966	.....	.....	.....	.....
Wayne	33	16	1	3	.....	97	150	240	.....	.....	.....	.....
Willow Springs	22	14	.....	1	.....	48	85	357	.....	.....	.....	.....
White Oak Springs	34	8	1	1	.....	4	48	219	.....	.....	.....	.....
Wiota	50	20	1	6	.....	76	153	439	.....	.....	.....	.....
Total	679	157	39	47	3	766	1,691	6,875	.....	.....	.....	6

TABLE 2.— Continued.

1860.	BRITISH AMERICA.						GREAT BRITAIN.						
	Canada.	New Brunswick.	Nova Scotia	New Foundland.	British America.	Total.	England.	Ireland.	Isle of Man.	Guernsey.	Scotland.	Wales.	Total.
Argyle	12	.....	1	.....	.....	13	82	59	.....	.....	19	1	161
Belmont	2	.....	.....	.....	.....	2	36	36	.....	.....	2	54	128
Benton	25	.....	.....	.....	1	26	481	352	6	.....	30	.....	869
Centre (Darl'ton)	54	1	2	.....	2	59	115	215	.....	.....	11	1	342
Elk Grove	17	1	.....	.....	2	20	264	160	3	4	11	2	444
Fayette	6	.....	.....	.....	.....	6	78	76	.....	.....	1	3	158
Gratiot	10	.....	.....	.....	.....	10	47	93	.....	.....	7	.....	147
Kendall	1	.....	.....	.....	.....	1	58	236	.....	.....	2	15	311
Monticello	47	1	.....	.....	.....	48	52	24	.....	.....	1	.....	77
New Diggings	7	.....	.....	.....	.....	7	369	399	.....	.....	5	.....	773
Shullsburg	36	.....	.....	1	.....	37	418	505	.....	.....	16	.....	939
Wayne	17	.....	.....	.....	.....	17	7	2	.....	.....	.....	.....	9
Willow Springs	3	.....	2	.....	.....	5	84	164	.....	.....	2	1	251
White Oak Spr.	6	1	.....	.....	.....	7	113	49	.....	.....	3	.....	165
Wiota	5	.....	.....	.....	.....	5	45	69	.....	.....	6	.....	120
Total	248	4	5	1	5	260	2,249	2,439	9	4	116	77	4,894

TABLE 2.—Continued.

1860.	REST OF EUROPE.										MISCELLANEOUS.		
	Denmark.	France.	Holland.	Italy.	Spain.	Switzerland.	Scandinavia.	Germany.	Prussia.	Total.	At sea.	Total.	Unknown
Argyle	.....	.....	.....	.....	.....	.....	207	1	2	210	.....	.....	...
Belmont	4	1	.....	.....	.....	2	14	2	13	36	.....	.....	
Benton	1	5	.....	1	.....	.....	.....	23	78	108	1	1	...
Centre (Darl'ton)	.....	1	.....	1	.....	3	5	15	37	62	1	1	
Elk Grove	.....	.....	.....	.....	.....	.....	1	10	95	106	.....	.....	
Fayette	.....	1	.....	.....	.....	1	21	13	4	40	.....	.....	...
Gratiot	.....	.....	.....	.....	.....	1	19	3	2	25	.....	.....	...
Kendall	.....	1	1	.....	1	4	.....	8	56	71	.....	.....	...
Monticello	.....	.....	.....	.....	.....	.....	.....	4	.....	4	.....	.....	...
New Diggings	.....	1	.....	.....	.....	.....	.....	2	14	17	.....	.....	
Shullsburg	1	15	.....	.....	.....	2	2	19	58	97	.....	.....	
Wayne	.....	.....	.....	.....	.....	.....	28	2	.....	30	.....	.....	...
Willow Springs	.....	.....	.....	.....	.....	5	2	4	17	28	.....	.....	...
White Oak Spr.	.....	.....	.....	.....	.....	.....	.....	.....	4	4	.....	.....	...
Wiota	.....	1	.....	.....	.....	2	218	.....	69	290	.....	.....	...
Totals	6	26	1	2	1	20	517	106	449	1,128	2	2	

TABLE 3.

1870.	NEW ENGLAND.							MIDDLE STATES.				
	Connecticut.	Maine.	New Hampshire.	Vermont.	Rhode Island.	Massachusetts.	Total.	New York.	New Jersey.	Pennsylvania.	Delaware.	Total.
Argyle	11	5	.....	4	.....	2	22	68	2	56	.....	126
Belmont	.....	3	.....	4	.....	4	11	42	1	53	.....	96
Benton	3	2	.....	.....	.....	5	10	8	3	15	.....	26
Blanchard	2	.....	1	4	.....	1	8	9	5	13	.....	27
Darlington Village	11	7	.....	47	.....	7	72	250	1	65	.....	316
Darlington town	4	10	3	15	.....	6	38	73	1	57	.....	125
Elk Grove	3	1	3	6	.....	3	16	23	10	26	3	62
Fayette	10	3	1	.....	.....	.....	14	47	.....	117	1	165
Gratiot	9	2	4	13	.....	6	34	193	.....	155	.....	348
Kendall	10	.....	1	1	.....	4	16	20	3	48	1	72
Monticello	2	1	.....	4	.....	.....	7	13	.....	38	.....	51
New Diggings	.....	.....	6	5	.....	14	25	30	3	13	.....	46
Seymour	1	.....	.....	2	.....	1	4	25	1	4	.....	30
Shullsburg	6	1	5	5	.....	19	36	49	13	26	.....	88
Wayne	6	42	6	11	.....	4	69	94	9	78	.....	181
White Oak Springs	2	1	1	1	.....	3	8	18	1	9	.....	28
Willow Springs	3	.....	1	.....	.....	1	5	45	.....	33	.....	78
Wiota	3	8	4	9	.....	7	31	96	6	87	.....	189
Total	86	86	36	131	.....	87	426	1,103	59	887	5	2,054

Table 3.— Continued.

1870.	Southern States.								Southwestern States.				
	Virginia.	North Carolina.	South Carolina.	Maryland.	Alabama.	Tennessee.	Kentucky.	Total.	Missouri.	Arkansas.	Louisiana.	Texas.	Total.
Argyle	3	.....	.....	.....	.....	2	1	6	1	.....	.....	.....	1
Belmont	14	2	2	4	.....	3	6	31	9	1	.....	.....	10
Benton	4	.....	.....	2	.....	3	5	14	10	1	1	.....	12
Blanchard	.....	1	.....	3	.....	.....	.....	4	1	.....	.....	.....	1
Darlington Vil...	8	.....	.....	2	.....	1	36	47	8	.....	2	.....	10
Darlington town	1	.....	.....	1	.....	2	20	24	2	.....	1	1	4
Elk Grove	2	.....	.....	10	.....	.....	4	16	.....	.....	.....	.....	.....
Fayette	3	1	.....	4	.....	17	7	32	.....	.....	.....	.....	.....
Gratiot	11	4	1	1	1	3	2	23	2	2	.....	.....	4
Kendall	2	.....	.....	.....	.....	1	2	5	2	.....	.....	.....	2
Monticello	.....	.....	1	.....	.....	1	1	3	.....	.....	.....	.....	.....
New Diggings	4	.....	1	5	1	2	6	19	3	.....	.....	.....	3
Seymour	2	.....	.....	.....	.....	1	.....	3	2	.....	2	.....	4
Shullsburg	14	1	.....	10	1	6	16	48	19	.....	.....	.....	19
Wayne	7	.....	.....	1	.....	6	7	21	3	.....	.....	.....	3
White Oak Spr..	1	1	.....	1	.....	2	1	6	2	.....	.....	.....	2
Willow Springs..	.....	.....	.....	2	.....	1	5	8	1	.....	.....	.....	1
Wiota	5	5	.....	4	1	13	10	38	5	.....	.....	.....	5
Total	81	15	5	50	4	64	129	348	70	4	6	1	81

TABLE 3.— Continued.

870.	NORTHWESTERN STATES.							WESTERN STATES.							MISCELLANEOUS.		
	Illinois.	Indiana.	Iowa.	Michigan.	Minnesota.	Ohio.	Total.	California.	Kansas.	Nebraska.	Oregon.	Nevada.	Total.	Wisconsin.	District Columbia.	United States.	Total.
. .....	26	11	3	3	....	38	81	2	2	....	....	....	4	515	....	....	..
t.....	58	5	17	1	1	61	143	....	....	....	....	....	....	600	....	....	..
.....	29	4	2	1	3	5	44	2	....	....	....	....	2	944	....	....	..
rd.....	9	2	....	6	....	6	23	....	....	....	....	....	....	208	....	....	..
ton, village	63	10	7	9	....	73	162	....	....	....	....	....	....	759	....	....	..
ton, town ..	25	1	2	1	....	37	66	....	....	....	....	....	....	576	....	...	..
ve.....	14	1	2	1	1	22	41	....	2	....	....	...	2	762	....	....	..
....	31	7	2	2	....	64	106	....	....	....	....	2	2	583	....	11	11
....	134	15	2	6	....	90	247	....	....	1	....	....	1	691	1	....	1
.....	31	4	1	....	...	31	67	....	....	....	....	....	....	596	....	....	..
llo....	37	3	....	9	....	22	71	...	....	....	....	1	1	231	....	....	..
ggings	49	5	5	4	....	4	67	....	....	....	....	....	....	952	....	....	..
r.	4	2	....	...	....	7	13	....	....	....	....	....	....	174	....	....	..
urg.....	73	4	10	5	1	17	110	13	....	....	....	....	13	1,437	....	....	..
.....	65	14	2	5	....	90	176	....	....	....	....	....	....	479	....	1	1
)ak Springs	45	4	1	....	1	4	55	....	1	....	....	....	1	286	...	....	..
Springs.....	20	7	6	4	....	31	68	3	....	....	....	....	3	612	....	4	4
.....	68	17	2	14	1	60	162	2	....	....	3	....	5	792	...	....	..
l.....	781	116	64	71	8	662	1,702	22	5	1	3	3	34	11,197	1	16	17

TABLE 3.— Continued.

1870.	BRITISH AMERICA.						GREAT BRITAIN.						
	Canada.	British Province.	Prince Edward Island.	New Brunswick.	Nova Scotia.	Total.	England.	Ireland.	Scotland.	Wales.	Isle of Man.	Cornwall.	Total.
Argyle	1	.....	.....	.....	.....	1	73	26	17	.....	.....	.....	121
Belmont	8	1	.....	.....	.....	9	100	73	4	79	.....	.....	256
Benton	16	.....	.....	.....	.....	16	319	270	15	.....	.....	.....	604
Blanchard	.....	.....	.....	.....	.....	.....	6	42	1	.....	.....	.....	49
Darlington Vil...	34	.....	.....	1	.....	35	138	125	6	4	.....	.....	273
Darlington town.	8	.....	.....	.....	1	9	46	134	8	.....	.....	.....	188
Elk Grove	6	.....	.....	2	.....	8	170	129	17	2	.....	.....	318
Fayette	4	.....	.....	.....	.....	4	71	83	1	.....	.....	.....	155
Gratiot	9	.....	.....	3	.....	12	85	139	14	.....	.....	1	239
Kendall	8	.....	.....	.....	.....	8	75	214	3	3	.....	.....	295
Monticello	12	.....	.....	.....	.....	12	51	28	2	1	.....	.....	82
New Diggings....	4	.....	.....	.....	.....	4	361	287	4	.....	.....	.....	652
Seymour	1	.....	.....	.....	.....	1	58	71	2	2	.....	.....	133
Shullsburg	22	.....	1	.....	.....	23	365	431	3	9	.....	.....	808
Wayne	10	.....	.....	1	1	12	11	19	2	.....	.....	.....	32
Willow Springs..	12	.....	.....	.....	.....	12	114	155	2	1	.....	.....	272
Wiota	9	.....	.....	.....	.....	9	61	90	8	1	2	.....	162
White Oak Spr..	5	.....	.....	.....	.....	5	90	47	1	.....	.....	.....	139
Total	169	1	1	7	2	180	2,199	2,363	110	102	3	1	4,778

TABLE 3.— Continued.

1870.	REST OF EUROPE.										MISCELLANEOUS.					
	Denmark.	France.	Holland.	Spain.	Switzerland.	Poland.	Scandinavia.	Germany.	Prussia.	Total.	India.	Australia.	Mexico.	Peru.	Total.	Unknown.
Argyle	...	...	...	...	...	...	301	1	....	302	...	...	...	...	...	...
Belmont	...	1	...	...	6	...	3	4	133	147	...	...	...	...	...	...
Benton	9	3	...	...	1	...	....	8	23	44	1	1	...	...	2	...
Blanchard	...	...	...	...	...	...	123	10	....	133	...	...	...	...	...	...
Darlington Village	...	...	...	...	...	...	24	14	9	47	...	...	...	...	...	...
Darlington town	...	1	...	...	...	...	20	2	....	23	...	...	...	...	...	...
Elk Grove	...	...	1	...	1	...	10	4	136	152	...	...	...	...	...	...
Fayette	...	...	...	...	...	...	98	17	....	115	...	2	...	...	2	...
Gratiot	...	1	...	...	3	...	55	37	20	116	...	...	...	...	...	...
Kendall	...	1	...	1	...	...	....	15	53	70	...	...	...	...	...	...
Monticello	...	...	...	...	2	...	3	1	16	22	...	...	...	...	...	...
New Diggings	...	1	...	...	...	...	....	....	20	21	...	...	...	...	...	1
Seymour	...	...	...	...	...	8	7	37	4	56	...	...	...	...	...	...
Shullsburg	...	6	...	...	6	...	5	19	59	95	...	...	2	19	21	3
Wayne	...	...	5	...	...	...	30	36	11	82	...	...	...	...	...	...
Willow Springs	...	5	...	...	1	...	3	35	7	51	...	...	...	...	...	...
Wiota	...	...	...	...	1	...	299	2	....	302	...	...	...	...	...	...
White Oak Springs	1	...	...	...	...	...	....	6	4	11	...	...	...	...	...	...
Total	10	19	6	1	21	8	981	248	495	1,789	1	3	2	19	25	4

TABLE 4.— *Population of Lafayette County.*

Towns.	1850.			1860.			1870.		
	Native born.	Foreign born	Total.	Native born.	Foreign born.	Total.	Native born.	Foreign born.	Total.
Argyle	305	116	421	714	284	1,098	755	424	1,179
Belmont	278	47	325	566	166	733	891	412	1,303
Benton	870	1,353	2,223	1,088	1,004	2,092	1,052	666	1,718
Blanchard	....	.....	.....	.....	.....	.....	271	182	453
Centre	472	129	601	1,473	464	1,938	.....	.....	.....
Darlington { Village	.....	.....	.....	.....	.....	.....	1,366	355	1,721
Darlington { Town	.....	.....	.....	.....	.....	.....	833	210	1,043
Elk Grove	361	262	623	740	570	1,315	899	478	1,377
Fayette	644	108	752	781	204	985	913	276	1,189
Gratiot	398	121	519	824	182	1,006	1,349	367	1,716
Kendall	260	73	333	745	383	1,128	758	373	1,131
Monticello	127	71	198	327	129	456	364	116	480
New Diggings	751	990	1,741	891	800	1,692	1,112	677	1,791
Seymour	.....	.....	.....	.....	.....	.....	228	190	418
Shullsburg	878	795	1,673	1,418	1,073	2,492	1,751	947	2,701
Wayne	309	25	334	617	56	673	930	126	1,056
Willow Springs	424	191	615	552	284	836	779	345	1,124
White Oak Springs	290	163	453	343	176	519	386	154	540
Wiota	540	183	723	847	415	1,262	1,222	474	1,696
Total	6,907	4,627	11,534	11,926	6,290	18,225	15,859	6,772	22,635

Note.—The above table was compiled from copies of the original returns in the office of the Secretary of State. The total for 1850 is increased by 9 for whom no birthplace is recorded, and the total for 1870 is increased by four from the same source.

TABLE 5.— *Areas, and population per square mile.*

LA FAYETTE COUNTY.	AREA IN SQUARE MILES.			POPULATION PER SQUARE MILE.		
	1850.	1860.	1870.	1850.	1860.	1870.
Argyle	54	54	36	7	30	32
Belmont	36	36	42	9	20	31
Benton	27.4	27.4	27.4	81	76	62
Darlington	74	74	76	8	26	49
Elk Grove	54	54	36	11	25	36
Fayette	35	35	35	21	29	34
Gratiot	61	54	54	9	18	31
Kendall	54	54	48	6	20	23
Monticello	10	19	19	19	24	24
New Diggings	23.6	23.6	23.6	65	63	68
Shullsburg	36	36	36	47	69	73
Wayne	33	36	35	9	18	29
White Oak Springs	16	16	16	28	32	33
Willow Springs	48	48	48	12	17	23
Wiota	60	60	60	12	19	28
Blanchard	.....	.....	18	.....	.....	25
Seymour	.....	.....	36	.....	.....	11

NOTE.— The above table was compiled from the Plat Book for 1895, office of Secretary of State, and from maps in State Historical Library.

MEMORIAL ADDRESSES.

EDWARD ORTON.

The many American geologists who since the death of Professor Edward Orton have paid tribute to his memory[1] lay much stress upon the beauty of his character. Wherever he was known, he was a valued friend, and from all his lovable nature and sterling worth called forth an affection but rarely seen between man and man. In the State of Ohio, where most of his life work was done and throughout which he traveled in pursuit of his investigations, he appears to have been looked upon as a great and good man whom it was an honor and a privilege to welcome and assist. Yet this lovable personality offers a striking instance of a man persecuted because the expansion of his intellect and the widening of his horizon of knowledge brought changes in his religious belief. Sensitive man that he was, these persecutions caused him much mental suffering.

[1]Memoir of Edward Orton, by G. K. Gilbert, Bull. Geol. Soc. Am. Vol. 11 (1900), pp. 542-550. (Includes a bibliography of Professor Orton's scientific writings.)

Edward Orton, by J. J. Stevenson. Jour. Geol. Vol. 8 (1900), pp. 205-213.

Edward Orton, by I. C. White. Am. Geologist. Vol. 25 (1900), pp. 197-210. (Contains a bibliography compiled by Lucy Allen, Ohio State University Library.)

Edward Orton, Educator, by T. C. Mendenhall. Science, N. S. Vol. 11 (1900), pp. 1-6.

Edward Orton, Geologist, by G. K. Gilbert. Ibid., pp. 6-11. (Not the article published in Bull. Geol. Soc. Am.)

The above articles have been freely used in compiling this article.

NOTE.—The Historical Collections of Ohio (Centennial Edition, 1899. Vol. 2, p. 59), contains a sketch of Dr. Orton's life which according to Gilbert is, though anonymous, clearly autobiographic.

Edward Orton

By courtesy of the American Geologist.

So dominant is the note of praise for Edward Orton the man, that one unfamiliar with Edward Orton the geologist and educator might think that it is only as the man that his name will be remembered. Yet surely a man who was chosen President of the American Association for the Advancement of Science, President of the Geological Society of America, President of a large State University, and for many years State Geologist of Ohio, must have some claim to recognition as a scientist and educator.

Edward Orton was born at Deposit, Delaware County, New York, March 9, 1829. His father, who was a Presbyterian clergyman, soon after removed to Ripley, New York, an agricultural community. Prepared for college by his father, at the age of fifteen he entered the sophomore class of Hamilton College, and graduated in 1848. After a year of teaching at Erie, Pa., he entered Lane Theological Seminary (Presbyterian) to prepare for the ministry, but his eyesight failing he gave up study at the end of a year and took a position as clerk on a coasting vessel. In 1851 he was Instructor in Natural Sciences and German in the Delaware Literary Institute of Franklin, New York. The following year he spent at Harvard University in study of chemistry and botany, returning to Franklin for another year of teaching. He then resumed his preparation for the ministry, this time at Andover Theological Seminary. Licensed to preach in 1845 he shortly thereafter was ordained as pastor of the Presbyterian church of Downsville, Delaware County, New York.

Yet with his course of study there had arisen doubts respecting matters of belief which warred against the doctrines instilled in his early life. In 1856 he resigned his pastorate to become professor of Natural Sciences in the New York State Normal School at Albany. Here, though not compelled to do so, he avowed his change of belief from that of the Presbyterian church to essentially Unitarian doctrines. In the fifties, before the days of evolution, the church was controlled by narrow and illiberal ideas, and most educational institutions were dominated by the church. This avowal of Dr. Orton's, therefore, was regarded as so serious a matter as to lose him the position which he held. The succeeding six years were spent in an obscure

academy, but in 1865 he was called to Antioch College, Ohio, by the acting president, who had learned to know and respect him. Dr. Orton felt that here at last was his opportunity, and he said, "The prison doors are at last opened for me." Driven from his own state by danger of persecution he felt that here his search for truth would be untrammeled. While at Antioch he was appointed assistant to Dr. Newbury, then State Geologist of Ohio, in which capacity he won such golden opinions that when, under the Morrill Act of 1862, the new State Agricultural and Mechanical College was founded, he was chosen for its President. The difficulties of this position may be better imagined than described. Ohio, always foremost among the states in the number of its strongly denominational colleges, naturally regarded the new institution as an interloper, but Professor Orton's tact was only equalled by the necessity for it, and notwithstanding the unpromising conditions, he was able to make of the Agricultural and Mechanical College the State University of Ohio as it is today. Prof. I. C. White says of this work:

"The unceasing toil of eight years which Dr. Orton had given to its interests had not only allayed all opposition but built up for it a host of friends in every portion of the state, so establishing it in the hearts of the people that its continued growth and influence have been phenomenal. The Ohio State University is so largely the creation of Dr. Orton's personal efforts that he needs no other monument to perpetuate his name and fame, not only as a great teacher, but also as a consummate organizer, director, and promoter of educational forces.[1]

President T. C. Mendenhall, who was associated with Dr. Orton for a period of thirty years, says of him:

"He believed that the character of an educational institution should be judged by the quality of its work rather than by the number of students enrolled in the annual catalogue, a principle which everybody admits and nearly everybody ignores. To stand up for it and do it, especially during the early struggling years of a college, demands a courage that few possess. That Dr. Orton did this, even under the most trying conditions, I set down as, on the whole, the most notable characteristic of his career as president. For I am thoroughly convinced that if he had chosen to do otherwise, if the doors had been opened wide, at both ends of the curriculum, the institution would have long since sunk into a deserved oblivion.[2]

[1] l. c. p. 200.
[2] l c. pp. 3–4.

Professor Orton's scientific work was very largely done in the state of Ohio in the capacity of assistant to Professor Newbury in 1869, as above described, and later as State Geologist, his activity as an officer of the state extending over a term of thirty years. The results are largely contained in the voluminous reports of the Ohio Geological Survey. Devoting himself largely to the problems of stratigraphy of the sedimentary formations and the superincumbent drift mantle, and to the economic resources of the state in coal, gas and oil, there is little that is spectacular or striking in his views, but the every-day problems which he studied were so thoroughly examined that his conclusions stand unchallenged. In his later years perhaps the best known specialist on natural gas in its relations to coal and oil in subterranean reservoirs, he is most widely known from the simple and adequate theory which he propounded to explain them.

Of his geological work, Mr. G. K. Gilbert says:

"As an investigator he generalized freely and did not shrink from the propounding of theories, but all his theories were so broadly founded upon, and so faithfully verified by, the phenomena of observation that they came to the world as demonstrations which could not be gainsaid."

Professor J. J. Stevenson says of him:

"The debt of geology to Edward Orton is very great, far greater than we are apt to think, for, in his writings he effaced himself and often gave credit to others for what was rightfully his own."

"We can lay a double tribute upon his grave, one to the man whom we loved and one to the geologist who solved so many perplexing problems."

Professor Orton died in 1899 after nine years of partial incapacity for work caused by a paralytic stroke. Only a short time before his death, however, he delivered an address as president of the American Association for the Advancement of Science. The Wisconsin Academy of Science, Arts, and Letters, in electing him to corresponding membership, chose a man whom all recognize as a worthy representative of American science, and who has been as widely known and loved as it is the privilege of a man of science to be.

William H. Hobbs.

JOHN EUGENE DAVIES.

John Eugene Davies was born at Clarkstown, N. Y., on the 23d of April, 1839. Two years later his parents moved to the city of New York, where he was sent to the public schools until twelve years of age, when he was admitted on examination to the Free Academy, now known as the University of the City of New York. In 1855 he came with his parents to Wisconsin, where he continued his studies as best he could, while teaching in the winters and doing farm work in the summers. He entered the sophomore class of Lawrence University, at Appleton, Wis., in 1859, and graduated from that institution three years later, with honors, by reason of special attainments in pure and applied mathematics.

After receiving his baccalaureate degree, he entered at once, through the solicitation of a physician friend, upon the study of medicine, yielding the more readily as he knew such a course would keep him somewhat in touch with the sciences, for which he was already acquiring a taste. But his studies were soon interrupted. The news of the battle of Pittsburg Landing, and of President Lincoln's call for "300,000 more," was too much for him to withstand, and he enlisted as a private in the 21st regiment, W. V. I.

His record as a soldier was varied, interesting, and highly creditable. He marched with his regiment, first to Covington, Kentucky, and afterward to Louisville, during General Bragg's approach from Chattanooga. At both places he served in the trenches and performed such other duties as fell to the lot of a private soldier. After General Bragg's retreat, he was, without solicitation, put on detail duty by Major-General Buell in one of the hospitals of Louisville. He was afterwards appointed Sergeant-Major of his regiment, and took part in the battles of Chickamauga and Mission Ridge. He served six months on picket duty on the top of Lookout Mountain, Tennessee; was with his regiment in all its fighting on the march to Atlanta, Georgia, and around that city, and on its backward march to Chattanooga, and he afterwards saw Atlanta burned. He was

JOHN EUGENE DAVIES.

By courtesy of the Wisconsin Alumni Magazine.

recommended for promotion at this time, but his commission as first lieutenant did not reach him until after the battle of Bentonville, and the army had entered Goldsboro, North Carolina. He finally accompanied Sherman on his famous "march to the sea," and returned home with his regiment by way of Richmond and Washington, having served three years without a day's furlough.

His war record was without a blemish. Entering the ranks as a private and from pure love of country, he served, it is true, in comparatively humble positions, but always with the highest courage and fidelity.

As soon as he was mustered out of service, he resumed his studies at the Chicago Medical College, and received the degree of Doctor of Medicine in the spring of 1868. He continued his attendance, however, at clinical lectures in Cook county hospital, and at Mercy hospital, until the end of August, 1868, when he came to Madison to enter upon his duties as professor of natural history and chemistry in the University of Wisconsin, to which chair he had been elected by the Board of Regents at their midsummer meeting. He had already occupied a professorship in the Chicago Medical College for a year, giving lectures on organic and inorganic chemistry and toxicology. In connection with the regular work of his professorship, Dr. Davies taught the subject of astronomy also in the University, and in 1874 the title of his chair was changed to that of astronomy and physics. In 1878 his chair was made to include physics only, and in 1891 it was changed to that of electricity and magnetism and mathematical physics, which chair he continued to hold at the time of his death.

Dr. Davies was a charter member of the Wisconsin Academy of Sciences, Arts, and Letters, was for many years its general secretary, and was always one of the Academy's most sincere and devoted friends, sharing liberally in its best contributions to the cause of science. He was also an active and efficient co-laborer upon the United States coast survey, contributing many manuscript volumes to its records, and performing special and very valuable service in the triangulation, and on the general geodetic survey of Wisconsin. It was through his inter-

cession that the department of the coast survey prevailed upon the Board of Regents to establish a magnetic observatory upon the grounds of the University, which for some years was used very efficiently under the Professor's general supervision.

He was married in March, 1866, to Miss Anna Burt, of Chicago. One child was born as the fruit of this marriage, but died in infancy. He was married again, March 31st, 1891, to Miss Olive M. Thayer, of Madison, who also bore him one child, a son, of whom he was very fond and who, with the widow, still survives.

Dr. Davies was a devotee of science and a thorough mathematician. He loved especially the natural sciences, and seemed to revel in the very mathematical calculations their investigation involved. Few men have been more fully imbued with the true scientific spirit. He was also a scholarly man, and one who read much and read widely. His contributions not only show careful though upon the subjects they discuss, but they also show a broad range of scientific inquiry. He was a modest man — seemed almost diffident at times—but his modesty was such as usually graces the genuine scholar and investigator. When antagonized upon questions which he had thoroughly studied, and in regard to which he felt reasonably sure of his ground, he was always resolute and self-reliant.

As an instructor of college classes, he was subjected, as most instructors are, to some criticism; but no one, so far as I know, ever made complaint as to his grasp of the subject he was called upon to teach; as to his zeal and enthusiasm in his efforts to impart instruction, or as to his sympathetic nature, and earnest desire to render the best possible service to those under his charge. The criticisms sometimes made were half complimentary. It has been urged that his very familiarity with the subjects he usually had under consideration made it difficult for him to appreciate the limitations of his pupils, and that his eagerness to grapple at once with the most difficult questions connected with the matter in hand, and his intense enthusiasm in their handling, tended to carry his instruction over the heads of the average of his pupils. But it is more than doubtful whether any who entered his classes with suitable preparation

WILLARD HARRIS CHANDLER.

and with an earnest determination to do thorough work, ever failed to profit by his instruction or had any personal ground for complaint.

Dr. Davies was a man of kindly nature, of deep sincerity, and of warm and generous impulses. He was domestic in his life and habits, as gentle as a child, and as true as steel to the demands of honor and the claims of friendship. Coming to the University in his early manhood, he gave his maturer life—his very best years—to its service. By that service he has won the lasting gratitude of every true friend of the University; and for his priceless qualities of heart and soul, his memory will always be warmly cherished by his neighbors and his colleagues, and especially by those who knew him longest and knew him best.

J. B. PARKINSON.

WILLARD HARRIS CHANDLER.

Willard H. Chandler was born in Brattleboro, Vermont, Nov. 18, 1830. He made the most of the educational advantages offered by his home school, until his fifteenth year, when he entered the office of the Vermont Phoenix, a weekly newspaper, where he remained, with the exception of a short period, until he came to Wisconsin in 1854. He first settled in Delavan, Walworth county. One year later he moved to Windsor, a few miles east of Madison, bought a piece of prairie land, and commenced to work out a farm. This farm he sold in 1668 and moved to Sun Prairie village, where he resided for twenty years. For the greater part of this time he was in the employ of the state, in some capacity or other. His liking for a farm home was so strong, however, that he purchased a fine tract of land near Sun Prairie village, which he improved and on which he resided at the time of his death, March, 1901.

His farm life was prosperous and characterized by the same energy, judgment and earnestness evinced by him in every undertaking.

His career as a servant of the state was most remarkable, especially when it is remembered that his school-days practically closed when he was fifteen years of age. But he was always a student, and his nine years of experience in every phase of work to be found in a newspaper office did much to make amends for the loss of school-room instruction in those early days. He was a thinker, and at all times honest and independent in his thinking. He was perhaps slow in reaching conclusions, but a conclusion once reached became a conviction to be lived up to. It may seem singular that one who had made no special preparation for educational work should have had so large a part in building up a great and connected public school system, and in directing the trend of educational work in a great state. Yet this is the case.

In 1856 he taught in an ungraded school near his home in Windsor; later he was made town superintendent of schools. When this system was abolished by legislative enactment, he was elected to the office of county superintendent, a position which he held for four years. He was most efficient in the discharge of the duties imposed by these positions, and his work attracted most favorable notice. In 1861 he was elected to represent his district in the Assembly. He at once became a recognized leader on his side of the House. He proposed and was able to secure much helpful legislation along educational lines, during the two years he represented his district. In 1863 he was elected to the State Senate, and was a member of that body for four years. Part of this time he was president pro tem., and his experience and acknowledged ability enabled him to secure very important legislation relating to the organization of our state normal schools, the first of which was opened at Platteville, in 1866. In 1871 he was made a member of the Board of Regents of Normal Schools, a position which he held continuously until 1892. For nine years of this time, from 1881 to 1890, he also held the position of Assistant State Superintendent of Public Instruction, and in this capacity he was instrumental in securing helpful legislation for the common schools, as well as the inauguration of needed reforms. The labor of organizing and outlining the work to be carried on by the teachers' institutes fell

largely under his direction, and through this work he was largely instrumental in bringing the normal school and common school work into close and vital connection. On his resignation of the secretaryship of the Board of Regents in 1892, the following resolution was unanimously adopted by the board:

"Whereas, W H. Chandler, for many years a member and secretary of this board, has just retired therefrom, and tenders his resignation of the secretaryship,

"Resolved, That in accepting such resignation, it is the sense of the board that as such member and secretary the service of Mr. Chandler to the normal schools of this state, in their establishment, extension and maintenance, and in the improvement and supervision of the instruction given, and in his efforts which have materially contributed to make these schools efficient and prosperous to a degree which will bear favorable comparison with like schools elsewhere, as well as in moulding and directing the institute work of the state for many years, has been of inestimable value to this board and to the public school system of Wisconsin, and that such services merit and should receive the cordial recognition and grateful acknowledgement of the board and the friends of public education throughout the state."

As a speaker, Mr. Chandler was clear and forceful. His familiarity with the details of school management and instruction, his clear knowledge of the body of the law relating to schools, as well as his earnest and sympathetic nature, enabled him to secure and hold the confidence and esteem of all with whom he came in contact in the educational field. He possessed a judicial temperament, and though perhaps not brilliant in the general acceptance of the term, he was always dignified, logical, and fair in the exposition of any topic which he discussed,—and never failed to secure attention. He was also a man of genial qualities and large benevolence. He was always ready to aid young men and women in securing education. It is safe to say that no worthy person with a meritorious purpose in view ever applied to Mr. Chandler for aid, without securing it.

He became a member of the Wisconsin Academy in 1872, and continued his membership until the time of his death. During the four years that he was inspector of high schools under the administration of State Superintendent Emery, it was my fortune and privilege to occupy a desk at his side, and, though he had ceased to take an active part in the proceedings

of the Academy, he was fond of discussing many of the topics presented at its annual meetings.

In closing his public labors, in January, 1899, he stated his intention of never again taking upon himself the burdens imposed by public office. He looked forward with pleasure to a season of rest and travel. The only journeys of any moment which proved possible for him to take, was one to the Pacific coast, where he spent a most delightful two months, and one to his old home in Vermont.

His three score years and ten were crowded full of high ideals and an unselfish purpose. His earnestness and ability have left an impress on this state that time will not efface and such as has been left by few other persons. The work which it was his fortune to do was done with courage and fidelity with all his heart, and with the mind and hand of a master.

CHARLES L. HARPER.

TRUMAN HENRY SAFFORD.

Truman Henry Safford[1] was born January 6, 1836, at Royalton, Vermont. His parents belonged to the great middle class to which we are indebted for so many of our teachers and professional men. Even in his infancy he showed signs of that marvelous power to deal with numbers mentally, which he possessed to an unusual degree throughout his entire life. When he was six years of age he said to his mother that if he knew

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[1]Arithmetical Prodigies, by E. W. Scripture, American Journal of Psychology, Vol. IV., No. 1.

Truman Henry Safford, by Harold Jacoby, Science, N. S., Vol. XIV., No. 340.

Truman Henry Safford, by H. P. Hollis, The Observatory, Vol. 24, No. 308.

The Late Professor Safford, by E. Knobel, The Observatory, Vol. 24, No. 309. Reference is made in this article to an article on "The Boy Safford" in Chambers' Edinburgh Journal for Oct., 1847.

Obituary Notice of T. H. Safford, by Arthur Earle, Astronomische Nachrichten, Bd. 157, No. 3749.

The above articles have been freely drawn upon in compiling this notice. I have also to thank Professors G. C. Comstock and C. F. Smith of the University of Wisconsin for important data concerning Professor Safford's like and work.

the number of rods around his father's large meadow he could tell the measure in barley corns, and when he was told that it was 1,040, he computed the result, 617,760, mentally in a few minutes. Before he was ten years old he had computed a table of logarithms of numbers from 1 to 60 from the formula given in Hutton's mathematics, and had constructed an almanac which was published. Before he was eleven he had constructed four more almanacs. It is related that on one occasion when he was about ten years old he performed the astonishing feat of finding the square of 365,365,365,365,365, giving the correct result, a number with thirty-six figures, in about one minute. This power of reckoning with large numbers and of discerning the divisors of large numbers he possessed to some extent throughout his life, but it was not nearly so marked in his later years.

He entered Harvard University at an early age and was graduated in 1854 at the age of 18, after having enjoyed the instruction of Benjamin Peirce, one of the foremost American mathematicians. After his graduation he remained for some years at Harvard as observer in the Harvard College Observatory under Professor Bond. In 1865 he came to Chicago as director of the old Dearborn Observatory, which position he held until the great fire of 1871 by which the observatory was destroyed. The people of the great city by the lake were too busy repairing the damage wrought by the fire to feel the need of a new observatory so the young astronomer had to seek employment in other fields. He found it in Wheeler's astronomical survey in the far west, and through this work became connected with various scientific bureaus at Washington. In 1876 he was made professor of Astronomy at Williams College, in which work he continued till his death June 12, 1901.

Professor Safford's real scientific work began in 1866 at Chicago, when he undertook the observation of one of the zones of the Astronomische Gesellschaft. This work was cut short, however, by the great fire of 1871. During the years between the great fire and his call to Williams College he seems to have been engaged principally in routine work, of which computation formed the greater part. While at Williamstown he took up the work of discussing the stars most suitable for the deter-

mination of geographical latitudes in the United States, and as a result of this labor constructed a catalogue of 2,018 stars, which was published by the Engineers' Department of the United States Army. This work was extended by a similar catalogue of 612 stars, which was published in 1898 as a part of the Mexican Boundary Commission's report. One of the latest papers published by him is a short paper entitled "Combinations of Pythagorean triangles as giving exercises in computation," which appeared in Vol. XII of the "Transactions" of the Wisconsin Academy. Perhaps his most striking work was the prediction in 1861 of the existence of the minute companion to Sirius, based on very small irregularities in the existing observation. The companion was found by Alvan Clark in the place indicated in 1862.

Professor Safford's life work was doubtless much influenced by the fact that when he went to Harvard the Harvard astronomers saw in him the making of a great computer, and his training was carried on with that side of astronomy always in view. He was a good astronomer and his work is of much value, but it is always the work of the patient observer and computer, and contains little of theoretical interest. Owing perhaps to the bent given him at Harvard, his work in pure mathematics is inconsiderable, although he undoubtedly possessed exceptional ability for such work. Indeed, from his writings and especially from his monograph on mathematical teaching one is led to believe that he looked upon mathematics rather as part of his physics than as a branch of knowledge to be cultivated for its own sake. He says, "The modern, and to my mind the true, theory is that mathematics is the abstract form of the natural sciences; and that it is valuable as a training of the reasoning powers not because it is abstract, but because it is the representation of actual things." For this reason he was not wholly in sympathy with "the new mathematical school—chiefly in certain branches of abstract higher algebra—recently established at the Johns Hopkins University."

As a teacher Professor Safford did not come into contact with a large number of students, but those who were instructed by him are unanimous in their testimony as to the value and the

inspiration of his work. In the article already referred to, Professor Harold Jacoby says of him, "Great as were his abilities as an astronomer, he was yet at his best as a teacher." The influence he exercised over a few bright students who resorted to Williamstown to profit by his instruction was undoubtedly great. On the other hand it has been said of him that his instruction was not adapted to the student not well advanced in his work. He himself probably realized this weakness as thoroughly as any one, for in the monograph on mathematical teaching, already mentioned, he insists strongly that we fail to recognize the difficulties that beset a beginner.

His range of information was very broad, not only along all lines of physical and natural science but in literature and in music as well. Says Professor Charles Forster Smith, "If, as a professor in Williams College, I became interested along any line of work whatever, I was sure of a cordial and sympathetic interest on the part of Professor Safford."

His home life is said to have been singularly happy. Careless and inattentive to the petty details of practical every day life, he gave these things over to the charge of his devoted wife, who took delight in relieving him from care and making it possible to give himself wholly to his books and his telescope. Professor Jacoby says, "He was a man of simple and genuine piety for whom the conflict of science and religion had no terrors. He knew that no such conflict exists." As a teacher, as an investigator and as a man he did honor to the college to which he gave the best years of his life.

ERNEST B. SKINNER.

LIST OF PUBLICATIONS OF THE LATE PROFESSOR SAFFORD.

The following list of Professor Safford's writings has been prepared through the kindness of Rev. Charles H. Burr, Librarian of Williams College. It is believed to be substantially complete:

SAFFORD, TRUMAN HENRY. Catalogue of declinations of 532 stars near the zenith of the observatory of Harvard College. (From American Academy, Memoirs. N. S. Vol. 8). Camb. 1861. folio. Welch, Bigelow & Co.

—— Catalogue of the mean declination of 2,018 stars between 0^h to 2^h and 12^h to 24^h right ascension and 10° and 70° of north declination for Jan. 1, 1875. Wash. 1879. folio. Govt.

—— Catalogue of the mean declinations of 981 stars between twelve hours and twenty-six hours of right ascension and thirty degrees and sixty degrees of north declination for Jan. 1, 1875. Wash. 1873. folio. Govt.

—— A catalogue of standard polar and clock stars for the reduction of observations in right ascension. (Harvard College Observatory, Annals, vol. 4). Camb. 1863. folio. Welch, Bigelow & Co.

—— Combinations of Pythagorean triangles as giving exercise in computation. (Wisconsin Academy of Sci., Arts, and Letters, Transactions, Vol. 12, pp. 505–8.) Madison. 1889. 8°.

—— Comparison of Groombridge's and Struve's right ascensions of close circumpolar stars. (Royal Astron. Soc., Monthly Notices, Vol. 46, No. 2.) L. 1885. 8°.

—— The development of astronomy in the United States. A discourse read June 25, 1888, to commemorate the fiftieth anniversary of the dedication of the Hopkins Observatory of Williams College. Boston. 1888. 8°. T. R. Marvin & Son.

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B. L. (Wisconsin). Principal of High School.

ROGERS, Augustus J., 318 Ogden Av., Milwaukee.
Ph. B. (Cornell). Principal of South Division High School.

RUENZEL, Henry Gottlieb, 753 Third St., Milwaukee.
Ph. G. (Wisconsin). Pharmacist; Member, State Board of Pharmacy.

RUSSELL, Harry Luman, 1532 Univ. Av., Madison.
B. S., M. S. (Wisconsin); Ph. D. (Johns Hopkins). Professor of Bacteriology, University of Wisconsin.

SALMON, Edward Payson, 618 Church St., Beloit.
A. M. (Beloit). Congregational Minister; Second Vice-President of Board of Trustees, Beloit College.

SANBORN, John Bell, Madison.
B. L., M. L., Ph. D. (Wisconsin).

SANFORD, Albert Hart, 1052 Clark St., Stevens Point.
B. L. (Wisconsin); A. B. (Harvard). Instructor in History and Civics, State Normal School.

SAUNDERSON, George William, Ripon.
A. B., A. M. (Dartmouth); LL B. (Boston). Professor of English Literature and Oratory, Ripon College.

SCHLUNDT, Herman, 202 Bruen St., Madison.
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SCOTT, William Amasa, 619 Langdon St., Madison.
A. B., A. M. (Rochester); Ph. D. (Johns Hopkins). Director of the School of Commerce and Professor of Economic History and Theory, University of Wisconsin.

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E. M. (Columbia); M. S. (Wisconsin).

SHARP, Frank Chapman, 27 Mendota Court, Madison.
A. B. (Amherst); Ph. D. (Berlin). Assistant Professor of Philosophy, University of Wisconsin.

SHERMAN, Lewis, 448 Jackson St., Milwaukee.
B. S., A. M. (Union); M. D. (New York).

SIEKER, William Christian, 131 Fourteenth St., Milwaukee.
B. S. (Wisconsin).

SKINNER, Ernest Brown, 414 Charter St., Madison.
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SLAUGHTER, Moses Stephen, 633 Francis St., Madison.
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SLICHTER, Charles Sumner, 636 Francis St., Madison.
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SMITH, Erastus Gilbert, 649 Harrison Av., Beloit.
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B. C. E., C. E. (Wisconsin). Assistant Professor of Topographic and Geodetic Engineering, University of Wisconsin.

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SNOW, Benjamin Warner, 518 Wisconsin Ave., Madison.
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LL. B. (Columbia). Member, Board of Commissioners of Fisheries, Wisconsin; President of the Eau Claire Public Library.

STANTON, Florence Belle, Lodi.
B. L. (Wisconsin). Teacher in High School.

SUYDAM, Vernon Andrew, Ripon.
B. S. (Wisconsin). Teacher in Ripon High School.

TALBERT, G. A., Oshkosh.

TAWNEY, Guy Allan, Beloit.
A. B., A. M. (Princeton); Ph. D. (Leipzig). Squier Professor of Mental Science and Philosophy, Beloit College.

TELLER, Edgar E., 170 Twenty-ninth St., Milwaukee.
President, Wisconsin Natural History Society.

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THWAITES, Reuben Gold, 260 Langdon St., Madison.
Secretary and Superintendent, State Historical Society of Wisconsin.

TIMBERLAKE, Hamilton Greenwood, 313 Mills St., Madison.
M. S. (Michigan). Instructor in Botany, University of Wisconsin.

TRUE, Rodney Howard, Washington, D. C.
B. S. (Wisconsin); Ph. D. (Leipzig).

TURNER, Frederick Jackson, 629 Francis St., Madison.
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UIHLEIN, August, 332 Galena St., Milwaukee.

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B. S., M. S., D. D. (Lawrence). Pastor, First Congregational Church.

UPHAM, Arthur Aquila, 106 Conger St., Whitewater.
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Superintendent of Schools and Principal of High School.

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B. S. (Wisconsin).

Voss, Ernst Karl Johann Heinrich,
23 E. Johnson St., Madison.
Ph. D. (Leipzig). Professor of German Philology, University of Wisconsin.

WATSON, Walter S., Whitewater.
M. S. (.....). Professor of Biology and German, State Normal School.

WEIDMAN, Samuel, 229 W. Gilman St., Madison.
B. S., Ph. D. (Wisconsin). Geologist, Wisconsin Geological and Natural History Survey.

WHITCOMB, Annabell Cook (Mrs. Henry F.), 721 Franklin St., Milwaukee.

WHITSON, Andrew Robinson, 420 Charter St., Madison.
B. S. (Chicago). Professor of Agriculutural Physics, University of Wisconsin.

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B. S. (Wisconsin). Fellow in Physics, University of Wisconsin.

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B. S., M. S. (Wisconsin). Instructor in Mathematics, University of Wisconsin.

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B. S., Ph. B. (Christiania); M. S. (Wisconsin). Assistant Professor of Agricultural Chemistry and Chemist to the Agricultural Experiment Station, University of Wisconsin.

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Ph. B. (Illinois Wesleyan); A. M. (Charles City). Principal, Seventeenth District School.

ZIMMERMANN, Oliver Bruner, 209 Brooks St., Madison.
B. M. E., M. E. (Wisconsin). Instructor in Machine Design and Descriptive Geometry, University of Wisconsin.

CORRESPONDING MEMBERS.

ABBOTT, Charles Conrad, Trenton, N. J.
M. D. (Pennsylvania).

ANDREWS, Edmund, 100 State St., Chicago, Ill.
A. B., A. M., M. D., LL. D. (Michigan). Professor of Clinical Surgery, Northwestern University; Surgeon, Mercy Hospital; Consulting Surgeon, Michael Reese Hospital and Illinois Hospital for Women and Children.

ARMSBY, Henry Prentiss, State College, Pa.
B. S. (Worcester Polytechnic); Ph. B., Ph. D. (Yale). Director of Experiment Station.

BASCOM, John, Park St., Williamstown, Mass.
A. B., A. M. (Williams); D. D. (Iowa); LL. D. (Amherst, Williams). Professor of Political Science, Williams College.

BENNETT, Charles Edwin, 1 Grove Place, Ithaca, N. Y.
A. B. (Brown). Professor of Latin Language and Literature, Cornell University.

BRIDGE, Norman,
217 S. Broadway, Los Angeles, Calif.; Oct. and Nov. each year, Rush Medical College, Chicago, Ill.
A. M. (Lake Forest); M. D. (Northwestern, Rush). Emeritus Professor of Medicine, Rush Medical College.

CAVERNO, Charles, Lombard, Ill.
A. B., A. M. (Dartmouth); LL. D. (Colorado). Clergyman, retired.

COULTER, John Merle, University of Chicago, Chicago, Ill.
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CROOKER, Joseph Henry, 110 N. State St., Ann Arbor, Mich.
D. D. (St. Lawrence, Nashville). Minister, Unitarian Church.

DAVIS, Floyd, 317 Iowa Loan and Trust Bldg., Des Moines, Ia.
Ph. B., C. E., E. M. (Missouri); Ph. D. (Miami). Analytical and Consulting Chemist.

ECKELS, William Alexander, Oxford, Ohio.
A. B., A. M. (Dickinson); Ph. D. (Johns Hopkins). Professor of Greek, Miami University.

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HENDRICKSON, George Lincoln, 5515 Woodlawn Av., Chicago.
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Ph. M. (Michigan). Secretary, Chicago Academy of Sciences; Editor, Birds and Nature.

HODGE, Clifton Fremont, 3 Charlotte St., Worcester, Mass.
A. B. (Ripon); Ph. D. (Johns Hopkins). Assistant Professor of Physiology and Neurology, Clark University.

HOLDEN, Edward Singleton, U. S. Military Academy, West Point, N. Y.
B. S., A. M. (Washington); S. D. (Pacific); LL. D. (Wisconsin and Columbia). Astronomer.

HOLLAND, Frederic May, Main St., Concord, Mass.
A. B. (Harvard).

HOSKINS, Leander Miller, Palo Alto, Calif.
B. S., M. S., B. C. E., C. E. (Wisconsin). Professor of Applied Mathematics, Leland Stanford Jr. University.

IDDINGS, Joseph Paxson, 5730 Woodlawn Av., Chicago, Ill.
Ph. B. (Yale). Professor of Petrology, University of Chicago.

KINLEY, David, Urbana, Ill.
A. B. (Yale); Ph. D. (Wisconsin). Dean of the College of Literature and Arts, and Professor of Economics, University of Illinois.

LEVERETT, Frank, Ann Arbor, Mich.
B. Sc. (Iowa Agricultural). Geologist, U. S. Geological Survey.

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266 S. College Av., Grand Rapids, Mich.
Chief Mortgage Clerk, Michigan Trust Co.; Treasurer of the Historical Society of Grand Rapids.

MARX, Charles David, Palo Alto, Calif.
B. C. E. (Cornell); C. E. (Carlsruhe). Professor of Civil Engineering, Leland Stanford Jr. University.

MCCLUMPHA, Charles Flint, Minneapolis, Minn.
A. B., A. M. (Princeton); Ph. D. (Leipzig). Professor of English Language and Literature, University of Minnesota.

MOOREHOUSE, George Wilton, 39 Cutler St., Cleveland, O.
B. L., M. L. (Wisconsin); M. D. (Harvard). Physician to the Dispensary of Lakeside Hospital and Western Reserve University.

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A. M., Ph. D. (Beloit). Clergyman; Editor, American Antiquarian.

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POWER, Frederick Belding, 535 Warren St., Hudson, N. Y.
Ph. G. (Phila. Coll. of Pharm.); Ph. D. (Strassburg). Director of Wellcome Chemical Research Laboratories, London, Eng.

RAYMOND, Jerome Hall, Chicago, Ill.
A. B., A. M. (Northwestern); Ph. D. (Chicago). Associate Professor of Sociology, University of Chicago.

SALISBURY, Rollin D., University of Chicago, Chicago, Ill.
A. M. (Beloit). Profesosr of Geographic Geology and Dean of the Graduate School of Science, University of Chicago; Geologist, U. S. Geological Survey, State Geological Survey, New Jersey.

SAWYER, Wesley Caleb, Elm and Asbury Sts., San Jose, Calif.
A. B., A. M. (Harvard); A. M., Ph. D. (Göttingen).

SHIPMAN, Stephen Vaughn, 269 Warren Av., Chicago, Ill.
Colonel, —— Regiment, U. S. Volunteers, Civil War; Architect.

STONE, Ormond, University Station, Charlottesville, Va.
M. A. (Chicago). Director, Leander McCormick Observatory and Professor of Practical Astronomy, University of Virginia.

TATLOCK, John, Jr., 32 Nassau St., New York, N. Y.
A. B., A. M. (Williams); F. R. A. S. Assistant Actuary, Mutual Life Insurance Co.

TOLMAN, Albert Harris, 5750 Woodlawn Av., Chicago, Ill.
A. B. (Williams); Ph. D. (Strassburg). Assistant Professor of English Literature, University of Chicago.

TOLMAN, Herbert Cushing, Nashville, Tenn.
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TOWNLEY, Sidney Dean, 2023 Bancroft Way, Berkeley, Cal.
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TRELEASE, William, Botanical Garden, St. Louis, Mo.
B. S. (Cornell); S. D. (Harvard); LL. D. (Wisconsin). Director of Missouri Botanical Garden and Henry Shaw School of Botany, Engelmann Professor of Potany, Washington University; Secretary, Academy of Science of St. Louis; Secretary, The Round Table, St. Louis; Honorary President, Engelmann Botanical Club, St. Louis.

VAN DE WARKER, Ely, 404 Fayette Park, Syracuse, N. Y.
M. D. (Albany Medical and Union). Surgeon Central New York Hospital for Women; Consulting Physician St. Ann's Maternity Hospital; Senior Surgeon Women's and Children's Hospital; Commissioner of Education, Syracuse; Member of the Holland Society.

VAN VLECK, Edward Burr, Middletown, Ct.
A. B., A. M. (Wesleyan); Ph. D. (Göttingen). Professor of Mathematics, Wesleyan University.

VERRILL, Addison Emory, 86 Whalley Av., New Haven, Ct.
S. B. (Harvard); A. M. (Yale). Professor of Zoölogy, Yale University.

WINCHELL, Newton Horace,
113 State St., Minneapolis, Minn.
A. M. (Michigan).

YOUNG, Albert Adams, 531 S. Claremont Av., Chicago, Ill.
A. B., A. M. (Dartmouth); D. B. (Andover). Clergyman.

MEMBERS DECEASED.

INFORMATION OF WHOSE DECEASE HAS BEEN RECEIVED SINCE THE ISSUE OF VOLUME XII.

ORTON, Edward, A. M., Ph. D., LL. D., **Columbus, Ohio.**
Professor of Geology, Ohio State University, State Geologist of Ohio, 1899.

DAVIES, John Eugene, A. M., M. D., LL. D., **Madison, Wis.**
Professor of Electricity and Magnetism and Mathematical Physics, University of Wisconsin; Jan. 22, 1900.

CHANDLER, Willard Harris, **Madison, Wis.**
State Inspector of High Schools; March 24, 1901.

SAFFORD, Truman Henry, Ph. D., **Williamstown, Mass.**
Field Memorial Professor of Astronomy, Williams College; June 12, 1901.

BACON, Charles Alfred, A. B., A. M., **Beloit, Wis.**
Professor of Astronomy, Beloit College, and Director of Smith Observatory; Sept., 1901.

STEELE, George McKendrae, D. D., LL. D., **Chicago, Ill.**
President of Lawrence University, 1865–1879; Principal Wesleyan Academy, Wilbraham, Mass., 1879–1893; Jan., 1902.

CONRATH, Adam, Ph. C., **Milwaukee, Wis.**
Pharmacist; Jan., 1901.

GOODHUE, William Fletcher, **Milwaukee, Wis.**
Civil Engineer; 1901.

JOHNSON, John Butler, C. E., **Madison, Wis.**
Dean of the College of Mechanics and Engineering, University of Wisconsin; June 30, 1902.

PROCEEDINGS.

REPORT OF THE SECRETARY, 1900.

THIRTY-FIRST ANNUAL MEETING.

MILWAUKEE, WIS., DEC. 27–28, 1900.

All meetings of the Academy were held in Club Room No. 486 of the Plankinton House. The several sessions were carried out in accordance with the printed program, with the exception of some few changes in the order in which the papers were read. This program was as follows:

THURSDAY MORNING, DECEMBER 27.

Reports of officers and other general business.

Address in memory of the late Professor John E. Davies, by Professor J. B. Parkinson.

Reading of papers at 10:15 o'clock.

1. An example of a theoretical system of weight factors of ready application in the solution of observation equations. *Albert S. Flint.*
2. On an improved method of determining latent heat of vaporization. *Louis Kahlenberg.*
3. The plankton of Green Lake and Lake Winnebago. *C. Dwight Marsh.*
4. Some recent observations on the migration of birds. *H. A. Winkenwerder.*

THURSDAY AFTERNOON.

5. Determinism, decrees, and immutable law. *Charles Caverno.*
6. Personal names, their etymology. *James D. Butler.*
7. A campaign cry of 1844. *H. J. Desmond.*
8. Shakespeare's knowledge of criminal psychology. *F. C. Sharp.*
9. Early political platforms in Wisconsin. *John G. Gregory.*

Friday Morning.

General business.

Reading of papers at 10:00 o'clock.

10. The cause of cleavage in rocks. *C. K. Leith.*
11. The supposed lessening of geyser activity in the Yellowstone National Park. *D. P. Nicholson.*
12. Harmonic curves of three frequencies. Second paper; with exhibition of stereograms drawn by E. A. Hook. *Charles S. Slichter.*
13. On repeating decimals. *E. A. Hook.*
14. On the thermal conductivity of the common woods. *L. W. Austin and C. W. Eastman.* (By title.)
15. The expansion of wood due to absorption of water. *L. W. Austin, G. S. Cassels and W. H. Barber.* (By title.)

Friday Afternoon.

16. The orientation of stream channels as related to geological structure. *William H. Hobbs.*
17. The old tungsten mine at Trumbull, Ct. *William H. Hobbs.*
18. The future of the clay and cement industry in Wisconsin. *Ernest R. Buckley.*

At the various sessions matters of business were transacted as follows:

THURSDAY, DEC. 27.

Morning Session.

The meeting was called to order at 9:30 o'clock by President Slichter. On motion, the reading of the minutes of the 30th annual meeting was dispensed with, on account of their publication during the intervening year in Vol. XII. of the "Transactions."

An informal report of the secretary was read. On account of the absence of the treasurer and librarian the reading of their reports was postponed till the meeting of Friday.

No further business was transacted during the day.

FRIDAY, DEC. 28, 1900.

The morning session was called to order by President Slichter. The report of the treasurer was read and accepted. The auditing committee, consisting of Messrs. Bruncken, Flint and

Leavenworth, previously appointed by the president, reported, approving the accounts of the treasurer.

The treasurer's report showed that the treasury contains $1,513.87, of which $1,000.00 are invested in a debenture bond, leaving the sum of $513.87 uninvested.

It was voted that the president and treasurer be hereby instructed to invest $500.00 of the above sum in interest bearing bonds, the said $500.00 to be added to the permanent fund of the Academy.

The committee on membership then made its report. On its recommendation the following names were added to the list of active members of the Academy:

B. W. Snow, Madison.
J. B. Parkinson, Madison.
J. C. Monaghan, Madison.
Howard L. Smith, Madison.
R. W. Wood, Madison.
E. K. J. H. Voss, Madison.
F. W. Meisnest, Madison.
Otto E. Lessing, Madison.
Walter H. Smith, Madison.
A. A. Meggett, Madison.
W. G. Bleyer, Madison.
H. G. Timberlake, Madison.
H. A. Winkenwerder, Madison.
E. R. Wolcott, Madison.
Bernard M. Palmer, Madison.
E. A. Hook, Madison.
S. T. Smythe, Delafield.
R. H. Halsey, Oshkosh.
J. E. Lough, Oshkosh.
W. S. Leavenworth, Ripon.
W. H. Neilson, Milwaukee.
G. A. Chamberlain, Milwaukee.
C. E. Monroe, Milwaukee.
J. A. Merrill, West Superior.
W. S. Watson, Whitewater.
L. J. Freese, Waukesha.
Chancey Juday, Madison.

Lewis Sherman, Milwaukee.
R. W. Pringle, Appleton.
A. O. Greason, Appleton.
V. A. Suydam, Ripon.
Miss Mary Armstrong, Portage.
Miss Gertrude Anthony, Madison.
Miss F. Belle Stanton, Warren, Ill.

The committee further recommended that former president, C. Dwight Marsh, and former secretary, Albert S. Flint, be elected to life membership in the Academy in view of their great services to the Academy during their term of office. This recommendation was unanimously adopted.

The report of the librarian was then read. As this report contained the statement that the present librarian deemed it his duty to resign in order that the work could be put into the hands of some one better versed in library matters and the library properly cared for, the report was referred to the Council of the Academy with the request that they formulate some motion upon the subject in time to be acted upon at the afternoon session.

The afternoon session was called to order at 2:45 by the president. The following recommendations presented by the Council were severally adopted:

Resolved, That the Librarian, Dr. Kahlenberg, be authorized to delegate to some person selected by himself any of the powers now belonging to his office.

Resolved, That the books of the Academy when catalogued shall be given a label of distinctive shape.

Resolved, That a selection of the most important transactions shall be kept in the room of the Academy at Madison.

The Council further recommend for passage at the next annual meeting the following amendment to the constitution:

Article VI. Section 2 is hereby amended to read as follows: The library committee shall consist of five members, of which the librarian shall be *ex-officio* chairman and of which a majority shall not be from the same city.

It was voted that this amendment be allowed to take its regular course.

F. C. SHARP,
Secretary.

REPORT OF THE SECRETARY, 1901.

THIRTY-SECOND ANNUAL MEETING.

MILWAUKEE, WIS., DEC. 26–27, 1901.

The meetings of the Academy were held in Room B 5 of the Milwaukee Normal School Building. The various meetings were carried out in accordance with the printed program with a few changes in the order of papers presented and the addition of four papers, the titles of which reached the secretary too late for printing. The program was as follows:

THURSDAY MORNING, DEC. 26.

Reports of officers and other general business.

Reading of papers at 10:30 o'clock.

1. The origin of Wisconsin place-names. *Henry E. Legler.*
2. The economic and social development of Kenosha county. *Robert H. Downes.*
3. The economic and social development of LaFayette county. *Katherine P. Regan.*
4. A study in longevity. *Charles H. Chandler.*
5. Language forms known as negative. *Edward T. Owen.*
6. The problem of interrogation. *Edward T. Owen.*

THURSDAY AFTERNOON.

7. The axial bifurcation of snakes. *Roswell H. Johnson.*
8. On a new species of Cantho-camptus from Idaho. *C. Dwight Marsh.*
9. Further notes on the plankton of Green Lake and Lake Winnebago. *C. Dwight Marsh.*
10. The marching of the young caterpillars of the maia moth, Hemileuca maia. *W. S. Marshall.*
11. The oak pruner, Elaphidion villosum. *W. S. Marshall.*
12. The early prophases of the nuclear division in the pollen of the mother cells of Larix and Lilium. *C. E. Allen.*
13. The development and structure of the swarm-spores of Hydrodiction. *H. G. Timberlake.*
14. Cell structure and reproduction in Hymenomycetes. *R. A. Harper.*

15. Some fungi parasitic on mushrooms. *R. A. Harper.*
16. Third supplementary list of parasitic fungi of Wisconsin. *J. J. Davis.*
17. Quinhydrones as plant pigments. *I. W. Brandel and Edward Kremers.*
18. A case of alum poisoning. *W. W. Daniells.*
19. The records left upon the soil of Wisconsin. *Stephen D. Peet.*

FRIDAY MORNING.

General business.

Reading of papers at 9:15 o'clock.

20. Migration velocities of the ions in solutions of silver nitrate in pyridine. *Herman Schlundt.*
21. Nitriles as solvents in molecular weight determinations. *Louis Kahlenberg.*
22. Instantaneous chemical reactions and the theory of electrolytic dissociation. *Louis Kahlenberg.*
23. A method of analyzing the inorganic acids. *W. S. Leavenworth.*
24. The action of selenic acid on gold. *Victor Lenher.*
25. Natural telluride of gold. *Victor Lenher.*
26. The action of tellurium and selenium on gold and silver salts. *Roy D. Hall.*
27. Note on the use of the terms "solvent" and "flux" for higher temperatures. *A. J. Rogers.*
28. Some complex nitro-compounds. *H. W. Hillyer.*

Memorial addresses:

Edward Orton, - - - *Wm. H. Hobbs.*
Willard H. Chandler, - - *C. L. Harper.*
Truman H. Safford, - - *Ernest B. Skinner.*
Charles A. Bacon, - - *E. G. Smith.*

FRIDAY AFTERNOON.

29. Evidence of the former extension of the Newark formation on the Atlantic slope. *Wm. H. Hobbs.*
30. Boulder trains in the Pomperaug valley, Connecticut. *Wm. H. Hobbs.*
31. The erosion history of southwest Wisconsin. *Ellwood C. Perisho.*
32. The physiographic features of central Wisconsin. *Samuel Weidman.*
33. The manner in which igneous rocks make their way to the surface. *C. R. Van Hise.*
34. Subterranean rivers. *Charles S. Slichter.*
35. The status of geological survey work in Missouri. *Ernest R. Buckley.*

Of the above papers Nos. 2, 3, 7, 8, 16, 21, 28, were read by title; No. 17 was presented by Professor Kremers, No. 22 by Dr. Schlundt, No. 24 by Professor Kremers, and No. 25 by Professor Van Hise.

Matters of business were transacted at the various sessions as follows:

THURSDAY MORNING, DEC. 26.

The Academy was called to order by President Slichter at 10:40 a. m. Owing to the fact that Mr. Legler was obliged to leave early in the forenoon, general business was postponed until after the reading of his paper. Mr. Legler's paper was discussed by Professor Chandler, Dr. Davis and others.

The report of the secretary was read. This report, besides giving the minutes of the meeting for 1900, stated that since the last meeting Part I of Vol. XIII of the "Transactions" of the Academy had been issued and distributed, and Part II is ready for the press.

The minutes were approved and the report accepted.

The report of the librarian was read by the secretary, the librarian being absent. The report which appears in full in another place, was accepted and placed on file.

The secretary read a letter from the Société Nationale des Sciences Naturelles et Mathématiques de Cherbourg, announcing the celebration of the fiftieth anniversary of the founding of the Cherbourg Society. By vote of the Academy the secretary was directed to enter upon the record a minute indicating that greetings and congratulations had been sent to the Society at Cherbourg.

A letter addressed to President Slichter by the secretary of the University Club of Milwaukee, extending the privileges of the Club to visiting members of the Academy during the meeting, was read by the secretary. The secretary was directed to reply to the invitation and to thank the Club for its hospitality.

The reading of papers was then resumed. Paper No. 4 was discussed by Professor Slichter. Papers 5 and 6 were discussed by Messrs. Van Hise, Slichter and others. Seventeen persons were in attendance at the morning session.

Thursday Afternoon.

The meeting was called to order at 2:40 by President Slichter. The reading of papers was taken up immediately and the transaction of business was postponed till later in the day. Papers 7 to 19 inclusive were read. Papers 9 and 17 were discussed by Professor Harper.

Mr. Peet's paper was an attempt to interpret certain symbols found in the Indian mounds of Wisconsin, and he made a strong plea for the preservation of the records left by the Indians.

The report of E. R. Buckley, treasurer, was read and accepted. The president appointed Messrs. Hillyer, Chandler and Kremers as auditing committee.

At the close of the report Dr. Buckley handed in his resignation as treasurer, a step made necessary by his removal from the state.

Friday Morning.

Professor Frank C. Sharp, secretary of the Academy, who has been absent in Europe for some months, handed in his resignation through President Slichter. This resignation and the resignation of the treasurer received on Thursday afternoon were accepted. President Slichter appointed as a committee to nominate officers to fill the vacancies, Professors Van Hise and Leavenworth and Dr. Schlundt.

The following amendment proposed at the annual meeting in December, 1900, was adopted:

Article VI, Section 2, is hereby amended to read as follows: The library committee shall consist of five members, of which the librarian shall be *ex-officio* chairman, and of which a majority shall not be from the same city.

The membership committee recommended the following named persons for active membership:

Paul H. Dernehl, Milwaukee.
Victor Lenher, Madison.
Roy Dykes Hall, Madison.
Roswell Hill Johnson, Madison.
E. C. Case, Milwaukee.

I. N. Mitchell, Milwaukee.
Samuel Edward Sparling, Madison.
William B. Cairns, Madison.
Charles Elmer Allen, Madison.
Andrew Robinson Whitson, Madison.
Alexander Rudolph Hohlfeld, Madison.
Ellwood C. Perisho, Platteville.
Irvin W. Brandel, Madison.
Robert Hugh Downes.
Katherine P. Regan.
William Christian Sieker, Milwaukee.
Richard C. Hughes, Ripon.
George Kirkpatrick, Ripon.
William Chase Bennett, Milwaukee.
Charles L. Harper, Madison.

By vote the secretary was instructed to cast the ballot for all the persons named. The ballot was cast and all were declared elected.

The committee further recommended that George P. Bacon of Beloit, a corresponding member who has returned to the state, be transferred from the list of corresponding members to the list of active members, and that G. A. Talbert of Oshkosh, formerly an active member, and having again taken up his residence in the state should be restored to active membership without payment of the initiation fee. The recommendations were adopted and both gentlemen put upon the list of active members.

The nominating committee reported, recommending that E. B. Skinner be chosen secretary to fill the unexpired term of F. C. Sharp, resigned, and H. W. Hillyer treasurer to fill the unexpired term of E. R. Buckley, resigned. The report was adopted and Messrs. Skinner and Hillyer were declared elected secretary and treasurer respectively to serve until after the annual meeting in 1902.

The reading of papers was then resumed. In the absence of the authors paper 22 was read by Dr. Schlundt, paper 24 by Professor Kremers and paper 25 by Professor Van Hise. No. 22 was discussed at some length by Professor Kremers, Dr. Schlundt and others, and No. 25 by Professors Van Hise and Hobbs.

Owing to lack of time the addresses in memory of W. H. Chandler, T. H. Safford and C. A. Bacon were omitted with the statement that they would appear in full in the "Transactions."

Attendance at morning session, about 45.

Friday Afternoon.

The meeting was called to order at 2:15 o'clock by President Slichter.

The auditing committee reported that they had examined the treasurer's books and had found them correctly cast and vouched.

President Slichter appointed as additional members to serve on the library committee, in accordance with the amendment to Article VI, Section 2, of the constitution as adopted Dec. 27, 1901, Messrs. Marsh, Jegi and Davis.

The remainder of the session was taken up with the reading of papers 29 to 35 inclusive. No. 31 was discussed at some length by Professor Van Hise and others.

The Academy adjourned *sine die*.

E. B. Skinner,
Acting Secretary.

REPORTS OF THE LIBRARIAN.

REPORT OF THE LIBRARIAN, 1900.

Since the last meeting of the Academy about thirty important serial publications have been added to the list of exchanges. The receipt of all publications sent to the Academy has been acknowledged and volume XII, part II, of the Academy's "Transactions," has been distributed.

During the month of September the entire library of the Academy was removed from the Capitol Building to the State Historical Library Building. The force of men that had just completed the moving of the library of the State Historical Society also transferred the library of the Academy to the new building. The Academy is greatly indebted to Mr. Reuben G. Thwaites for thus placing at its disposal the services of these men, who accomplished the transfer of the whole collection without expense to the Academy. To Mr. W. M. Smith, who supervised the moving of the books and their disposal on the shelves of the stack room, the Academy also owes a debt of gratitude.

The Academy is to be congratulated that its valuable collection of books is now housed in the magnificent fire-proof building that also contains the libraries of the State Historical Society and the State University. The volumes of the Academy are placed in a separate part of the stack room, and they will henceforth be more secure and more accessible than ever before.

In the past, one of the most important duties of the librarian has been to endeavor to increase the size of the library by adding to the number of exchanges; while this will always remain an important duty, the number of volumes already in the collection, and the fact that they are now permanently placed in the

new building, call for a great deal of work in properly arranging and cataloguing the books so as to make them readily available. A good card catalogue should be prepared and kept at the library, and members should be furnished a new printed list of exactly what the library contains. Many of the volumes are still unbound. Before the work of binding can proceed, however, the numbers that are lacking to complete various sets must be secured. Besides looking over the entire library carefully, this will involve considerable work in the way of correspondence. The effort of the Academy should be to get its library into such condition that the treasures which it contains may be readily accessible to all.

To do the work here outlined requires time and skilled help; indeed the services of an expert librarian are indispensable for its accomplishment. Again, to issue promptly at any time such books as may be required necessitates the presence of the librarian in the library building. An opportunity has now happily presented itself to accomplish all that ought to be done with little or no expense to the Academy beyond what has usually been annually expended for assistance in the library. Since the books have been moved into the new library building Mr. W. M. Smith has kindly consented to act as my deputy in arranging the volumes, acknowledging the receipt of exchanges, etc. On becoming acquainted with the value of the library and its actual needs, he has kindly offered to enter into the work of securing additional exchanges, of completing the sets already at hand and preparing them for the bindery, and of arranging the books systematically on the shelves, and cataloguing them in a proper manner. He has offered further to issue promptly at all times such books as may be wanted, thus making the volumes of the Academy properly accessible for the first time. All this he has offered to do, as already stated, without expense to the Academy beyond what it has been accustomed to pay for clerical services. This work on the part of Mr. Smith would be simply a labor of love. The offer has been prompted solely by a sincere desire to make the library of use as it should be.

When I accepted the office of librarian I had but a faint idea of the true condition of the library and of the large amount of expert work that ought to be done upon it. I must confess

that I do not see how I could possibly give the library the amount of time that would be necessary to do the required work, even if I were sufficiently versed in library matters. It therefore seems to me that the Academy ought to accept Mr. Smith's offer gladly and to vest him with full authority to do the work here detailed. In order that this may be done, I deem it my duty to hereby tender my resignation as librarian of the Academy so that Mr. Smith may be elected for the unexpired term and may at once proceed vigorously with the work.

LOUIS KAHLENBERG,
Librarian.

Madison, Wis., Dec. 27, 1900.

REPORT OF THE LIBRARIAN, 1901.

The books constituting the library of the Wisconsin Academy of Sciences, Arts and Letters are now carefully arranged on the shelves of stack F of the Historical Library Building. The work of completing sets and binding volumes is in progress. About one hundred and fifty volumes have been sent to the bindery thus far.

Members of the Academy may at any time obtain books from the library without delay. If requests for books are sent directly to the office of the Librarian of the University, the desired volumes will be sent out on the same day that such request is received.

The Regents of the University have greatly aided the work connected with the Academy library by placing at the disposal of the Librarian of the Academy the library staff of the University under the direction of Librarian Smith. To the latter the Academy is especially indebted for the interest he has taken in the work.

LOUIS KAHLENBERG,
Librarian.

Madison, Wis., Dec. 24, 1901.

REPORTS OF THE TREASURER.

REPORT OF THE TREASURER

for the year ending December 31, 1900.

The treasurer would respectfully report that the total active membership of the Academy is 179.

Five members have been dropped from the list by request or for non-payment of dues. Of the total membership 136 have paid dues up to date or beyond; 16 are one year in arrears; 14 are two years in arrears; 4 are three years in arrears; 7 are four years in arrears; 2 are five years in arrears.

I would respectfully recommend that members now four years or more in arrears be dropped from the Academy roll in compliance with the resolution passed by the Academy at its annual meeting in 1892. If no objections are raised such names will be stricken from the list of members.

Accompanying this report is a statement of the finances of the Academy with vouchers for expenditures. There is now in the treasury one thousand five hundred and thirteen dollars and eighty-seven cents ($1,513.87). One thousand dollars is invested in a debenture bond bearing 5 per cent interest, payable January 1st, 1901. Five hundred and thirteen dollars and eighty-seven cents ($513.87) are in the general fund, an increase of seventy-five dollars and forty-four cents ($75.44) over the balance of December 28th, 1899.

At the beginning of the year the treasurer was authorized to purchase a new set of books and transfer all the accounts. This was done and the books accompany this report for inspection.

Respectfully submitted,

E. R. Buckley,

Treasurer.

Statement, 1899–1900.

Cash.

1899.		Dr.	Cr.
Dec. 28.	To balance on hand	$438 43	
1900.			
Dec. 27.	To dues	197 50	
Dec. 27.	To interest on bond.....	50 00	
Dec. 27.	By printing ..... (Vouchers Nos. 6, 8, 9, 11, 15, and 16.)		$72 40
Dec. 27.	By clerical services and miscellaneous supplies for librarian..... (Vouchers Nos. 1, 2, 3, 4, 7, 10, 12, 17, 18, 21, 24.)		33 47
Dec. 27.	By clerical services and miscellaneous supplies for secretary..... (Vouchers Nos. 5, 13, 14, 22, and 23.)		50 56
Dec. 27.	By clerical services and miscellaneous supplies for treasurer..... (Vouchers Nos. 19 and 20.)		15 63
Dec. 27.	Balance		513 87
		$685 93	$685 93

The above report of the treasurer was duly examined by the auditing committee appointed by the chair, and found correct.

Ernest Bruncken,
W. S. Leavenworth,
Albert S. Flint,
Auditing Committee.

REPORT OF THE TREASURER

for the year ending December 27, 1901.

During the last two years there has been a total of 219 names on the roll of active members. Eight of these are names of persons who were elected to membership but failed to qualify. Omitting this number, leaves a total of 211 active members during the years 1900 and 1901. Of this number one has died;

two have been elected life members; two have been elected corresponding members; five have been dropped by request, dues having been paid up to current year; two have been dropped by request, dues having not been paid; and fourteen have been dropped for non-payment of dues for four consecutive years.

This makes a total of twenty-four names removed from the roll of active members, leaving a net active membership of one hundred and eighty-five (185).

Of the 185 active members there are thirty that are in arrears for payment of dues, as follows:

1 for 5	years		$5 00
5 for 3	years		15 00
4 for 2	years		8 00
19 for 1	year		19 00
1 for ½	year		50
30	Total		$47 50

Of the 155 members whose dues are paid to date, five, namely, the president, secretary, acting secretary, librarian and treasurer have had their dues remitted according to the by-laws of the Academy. This leaves a net total of 150 members paying dues for the year 1901. One of this number paid dues for five years; one for four years; six for three years; thirty-four for two years, and one hundred and eight for one year.

E. B. Copeland, S. A. Hooper and E. D. Jones are at present non-residents of Wisconsin and I would recommend that they be transferred to the list of corresponding members with the remission of such dues as may now be unpaid.

At the meeting of the Academy last year it was voted to transfer $500.00 from the general to the permanent fund. The bonds, in which the $1,000 permanent fund of the Academy were invested, became due January 1st, 1902. These bonds *had* been paying 5 per cent. interest, but owing to a reduction in interest rates, re-investment in the same bonds would now only return 4 per cent. The treasurer was instructed to reinvest in bonds the $1,000, and also the $500 transferred from the general to the permanent fund.

In accordance with these instructions application was made to the Clerk of the City of Madison for 15 street improvement

bonds. These bonds, which bear 6 per cent. interest, were obtained about the middle of May at a small premium. The treasurer invested $1,508.00 in fourteen bonds, there not being sufficient money on hand to purchase the fifteenth. The additional bond, however, was taken up by President C. S. Slichter and will be turned over to the Academy as soon as there are sufficient funds to pay the same. These are long term bonds, extending from six to ten years, three being payable the first year and four each succeeding year. They will net the Academy a little over five per cent.

I would recommend that all moneys invested in these bonds, not already part of the permanent fund, be transferred to such fund; that hereafter all interest accruing from the investment of the permanent fund be added to the permanent fund and invested from time to time as directed by the council.

The following is a recapitulation of the financial transactions of the Academy for the year 1900, and an itemized statement of the receipts and expenditures for the year 1901.

Statement, 1899–1900.

RECEIPTS.

1899.		
Dec. 28.	Balance on hand in general fund.....	$438 00
1900.		
Dec. 27.	Receipts from dues for year 1900.....	197 00
Dec. 27.	Interest on permanent fund, 1900.....	50 00
	Total	$685 00

EXPENDITURES.

1900.		
Dec. 27.	General and incidental expenses for 1900.....	$171 13
	Balance on hand in general fund Dec. 27, 1900....	$513 87
	Permanent fund	1,000 00
	Grand total	$1,513 87

Statement, 1900–1901.

RECEIPTS.

1900.		
Dec. 27.	Balance on hand in general fund.....	$513 87
1901.		
Dec. 26.	Receipts from dues for 1901.....	206 00
	Interest on permanent fund 6 mo. to Jan. 1, 1901..	25 00
	Interest on $1,000 deposited in bank for 4 mo. at 2%	6 67
	Total receipts	$751 54
1901.		
May 31.	Transferred to permanent fund.....	$508 00
	Balance in general fund.....	$243 54

EXPENDITURES.

No. of sub-voucher.			
1.	Dec. 31.	Anna L. Moore	$1 00
2.	Jan. 15.	Stamps (Treasurer)	4 00
3.	Jan. 23.	Schwab Stamp Co.	1 60
4.	Jan. 14.	Miss Beecroft	8 29
5.	Jan. 14.	Miss Beecroft	1 75
6.	Jan. 15.	Dr. Hobbs	2 00
7.	Feb. 4.	G. A. Mowry	4 10
8.	Mch. 4.	Wm. J. Park & Co.	8 50
9.	Mch. 16.	Miss Beecroft	30
10.	Mch. 18.	L. C. Burke	35 50
11.	Feb. 4.	H. C. Johnson	5 40
12.	Feb. 4.	Stamps	1 00
13.	May 23.	Schwab Stamp & Seal Co.....	2 05
14.	June 15.	W. Leonard	14 00
15.	Aug. 20.	Stamps (Secretary)	2 00
16.	Nov. 11.	Stamps (Treasurer)	2 00
17.	Dec. 8.	Stamps (Secretary)	6 00
18.	July 2.	M. E. Yager	11 55
19.	Aug. 3.	Haswell & Scholl	40 75
20.	Aug. 6.	L. C. Burke	26 25
21.	Oct. 25.	Democrat Ptg. Co.	19 50
22.	Oct. 25.	Tracy, Gibbs & Co.	17 60
23.	Dec. 5.	E. D. Lorigan	2 00
24.	Dec. 5.	Herman Schlundt	80
25.	Dec. 5.	F. C. Sharp	1 10

26.	Dec.	5.	Menges' Pharmacy	80
27.	Dec.	5.	Capital City Paper Co.....	3 00
28.	Dec.	5.	Philip Gross Hardware Co.....	3 50
				$226 34
			Net receipts	$243 54
			Balance in general fund	$17 20
			Balance in permanent fund	$1,508 00
			Grand total	$1,525 20

In conclusion, I desire to express to the members my appreciation of their promptness in meeting the financial obligations which they have had toward the Academy. I regret exceedingly that it becomes necessary for me, at this time, to tender you my resignation as treasurer.

Respectfully submitted,

E. R. Buckley,
Treasurer.

The Committee appointed to audit the accounts of the Treasurer of Wisconsin Academy of Sciences, Arts, and Letters report that they have examined his accounts and find them correctly cast and vouched.

H. W. Hillyer,
Edward Kremers,
Chas. H. Chandler,
Auditing Committee.

Milwaukee, Wis., Dec. 27, 1901.

EXTRACTS FROM THE CHARTER.

AN ACT to incorporate the Wisconsin Academy of Sciences, Arts, and Letters.

The people of the state of Wisconsin, represented in senate and assembly, do enact as follows:

SECTION 1. Lucius Fairchild, Nelson Dewey, John W. Hoyt, Increase A. Lapham, * * *[1] at present being members and officers of an association known the "The Wisconsin Academy of Sciences, Arts, and Letters," located at the city of Madison, together with their future associates and successors forever, are hereby created a body corporate by the name and style of the "Wisconsin Academy of Sciences, Arts, and Letters," and by that name shall have perpetual succession; shall be capable in law of contracting and being contracted with, of suing and being sued, of pleading and being impleaded in all courts of competent jurisdiction; and may do and perform such acts as are usually performed by like corporate bodies.

SECTION 2. The general objects of the Academy shall be to encourage investigation and disseminate correct views in the various departments of science, literature, and the arts. Among the specific objects of the Academy shall be embraced the following:

1. Researches and investigations in the various departments of the material, metaphysical, ethical, ethnological, and social sciences.
2. A progressive and thorough scientific survey of the state with a view of determining its mineral, agricultural, and other resources.
3. The advancement of the useful arts, through the applications of science, and by the encouragement of original invention.
4. The encouragement of the fine arts, by means of honors and prizes awarded to artists for original works of superior merit.
5. The formation of scientific, economic, and art museums.
6. The encouragement of philological and historical research, the collection and preservation of historic records, and the formation of a general library.
7. The diffusion of knowledge by the publication of original contributions to science, literature, and the arts.

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[1] Here follow the names of forty others. Sections 5, 6, 8, and 9 are omitted here as of no present interest. For the charter in full see *Transactions*, vol. viii, p. xi, or earlier volumes.

SECTION 3. Said Academy may have a common seal and alter the same at pleasure; may ordain and enforce such constitution, regulations, and by-laws as may be necessary, and alter the same at pleasure; may receive and hold real and personal property, and may use and dispose of the same at pleasure; *provided*, that it shall not divert any donation or bequest from the uses and objects proposed by the donor, and that none of the property acquired by it shall, in any manner, be alienated other than in the way of exchange of duplicate specimens, books, and other effects, with similar institutions and in the manner specified in the next section of this act, without the consent of the legislature.

SECTION 4. It shall be the duty of the said Academy, so far as the same may be done without detriment to its own collections, to furnish, at the discretion of its officers, duplicate typical specimens of objects in natural history to the University of Wisconsin, and to the other schools and colleges of the state.

SECTION 7. Any existing society or institution having like objects embraced by said Academy, may be constituted a department thereof, or be otherwise connected therewith, on terms mutually satisfactory to the governing bodies of the said Academy and such other society or institution.

Approved March 16, 1870.

EXTRACTS FROM THE WISCONSIN STATUTES.

STATUTES OF 1898.

TRANSACTIONS OF THE ACADEMY.

SECTION 341. There shall be printed by the state printer biennially in pamphlet form two thousand copies of the transactions of the Wisconsin Academy of Sciences, Arts, and Letters, uniform in style with the volumes heretofore printed for said society.

CHAPTER 22.

OF THE DISTRIBUTION OF PUBLIC DOCUMENTS.

SECTION 365. The transactions of the Wisconsin Academy of Sciences, Arts, and Letters shall be distributed as follows: One copy to each member of the legislature, one copy to the librarian of each state institution; one hundred copies to the State Agricultural Society; one hundred copies to the State Historical Society; one hundred copies to the State University, and the remainder to said Academy.

SECTION 366. In the distribution of books or other packages, if such packages are too large or would cost too much to be sent by mail, they shall be sent by express or freight, and the accounts for such express or freight charges, properly certified to, shall be paid out of the state treasury.

STATUTES OF 1901.

CHAPTER 447.

BINDING OF EXCHANGES.

SECTION 1. Section 341 of the revised statutes of 1898 is hereby amended by adding thereto the following: The secretary of state may authorize the state printer to bind in suitable binding all periodicals and other exchanges which the Society shall hereafter receive, at a cost not exceeding one hundred and fifty dollars per annum. The secretary of state shall audit the accounts for such binding.

NOTE.—The Academy allows each author one hundred separates of his paper from the Transactions without expense to the author, except a small charge for printed covers when desired.—EDITOR.

CONSTITUTION

OF THE WISCONSIN ACADEMY OF SCIENCES, ARTS, AND LETTERS.

[As amended in Articles V, VI andIX at the regular meetings of December, 1899 and December, 1901.]

ARTICLE I.—*Name and Location.*

This association shall be known as the Wisconsin Academy of Sciences, Arts, and Letters, and shall be located at the city of Madison.

ARTICLE II.—*Object.*

The object of the Academy shall be the promotion of sciences, arts, and letters in the state of Wisconsin. Among the special objects shall be the publication of the results of investigation and the formation of a library.

ARTICLE III.—*Membership.*

The Academy shall include four classes of members, viz.: life members, honorary members, corresponding members, and active members, to be elected by ballot.

1. Life members shall be elected on account of special services rendered the Academy. Life membership in the Academy may also be obtained by the payment of one hundred dollars and election by the Academy. Life members shall be allowed to vote and to hold office.

2. Honorary members shall be elected by the Academy and shall be men who have rendered conspicuous services to science, arts, or letters.

3. Corresponding members shall be elected from those who have been active members of the Academy, but have removed from the state. By special vote of the Academy men of attainments in science or letters may be elected corresponding members. They shall have no vote in the meetings of the Academy.

4. Active members shall be elected by the Academy and shall enter upon membership on the payment of an initiation fee of two dollars which shall include the first annual assessment of one dollar. The annual assessment shall be omitted for the president, secretary, treasurer, and librarian during their term of office.

ARTICLE IV.—*Officers.*

The officers of the Academy shall be a president, a vice-president for each of the three departments, sciences, arts, and letters, a secretary, a librarian, a treasurer, and a custodian. These officers shall be chosen by ballot, on recommendation of the committee on nomination of officers, by the Academy at an annual meeting and shall hold office for three years. Their duties shall be those usually performed by officers thus named in scientific societies. It shall be one of the duties of the president to prepare an address which shall be delivered before the Academy at the annual meeting at which his term of office expires.

ARTICLE V.—*Council.*

The council of the Academy shall be entrusted with the management of its affairs during the intervals between regular meetings, and shall consist of the president, the three vice-presidents, the secretary, the treasurer, the librarian, and the past presidents who retain their residence in Wisconsin. Three members of the council shall constitute a quorum for the transaction of business, provided the secretary and one of the presiding officers be included in the number.

ARTICLE VI.—*Committees.*

The standing committees of the Academy shall be a committee on publication, a library committee, and a committee on the nomination of members. These committees shall be elected at the annual meeting of the Academy in the same manner as the other officers of the Academy, and shall hold office for the same term.

1. The committee on publication shall consist of the president and secretary and a third member elected by the Academy. They shall determine the matter which shall be printed in the publications of the Academy. They may at their discretion refer papers of a doubtful character to specialists for their opinion as to scientific value and relevancy.

2. The library committee shall consist of five members, of which the librarian shall be *ex officio* chairman, and of which a majority shall not be from the same city.

3. The committee on nomination of members shall consist of five members, one of whom shall be the secretary of the Academy.

ARTICLE VII.—*Meetings.*

The annual meetings of the Academy shall be held between Christmas and New Year, at such place as the council may designate; but all regular meetings for the election of the board of officers shall be held at Madison. Summer field meetings shall be held at such times and places as the Academy or the council may decide. Special meetings may be called by the council.

ARTICLE VIII.—*Publications.*

The regular publication of the Academy shall be known as its Transactions, and shall include suitable papers, a record of its proceedings, and any other matter pertaining to the Academy. This shall be printed by the state as provided in the statutes of Wisconsin. All members of the Academy shall receive gratis the current issues of its Transactions.

ARTICLE IX.—*Amendments.*

Amendments to this constitution may be made at any annual meeting by a vote of three-fourths of all the members present; *provided*, that the amendment has been proposed by five members, and that notice has been sent to all the members at least one month before the meeting.

RESOLUTIONS

REGULATIVE OF THE PROCEEDINGS OF THE ACADEMY.

THE TRANSACTIONS OF THE ACADEMY.

[*By the Academy, December 28, 1882. Transactions, Vol. VI, p. 350.*]

2. The secretary of the Academy shall be charged with the special duty of overseeing and editing the publication of future volumes of the Transactions.

3. The Transactions of the Academy hereafter published shall contain: (a) a list of officers and members of the Academy; (b) the charter, by-laws and constitution of the Academy as amended to date; (c) the proceedings of the meetings; and (d) such papers as are duly certified in writing to the secretary as accepted for publication in accordance with the following regulations, and no other.

6. In deciding as to the papers to be selected for publication, the committee shall have special regard to their value as genuine, original contributions to the knowledge of the subject discussed.

9. The Sub-Committee on Publication shall be charged with insisting upon the correction of errors in grammar, phraseology, etc., on the part of authors, and shall call the attention of authors to any other points in their papers, which in their judgment appear to need revision.

[*By the Academy, June 2, 1892, Vol. IX, p. ii.*]

The secretary was given authority to allow as much as ten dollars for the illustrations of a paper when the contribution was of sufficient value to warrant it. A larger amount than this might be allowed by the Committee on Publication.

[*By the Academy, December 29, 1896, Vol. XI, p. 558.*]

The secretary was directed to add to the date of publication as printed on the outside of author's separates the words, "Issued in advance of general publication."

FEES OF LIFE MEMBERS.

[*By the Academy, July 19, 1870, Vol. I, p. 187.*]

Resolved, That the fees from members for life be set apart as a permanent endowment fund to be invested in Wisconsin state bonds, or other equally safe securities, and that the proceeds of said fund, only, be used for the general purposes of the Academy.

ANNUAL DUES.

[*By the Academy, December 29, 1892, Vol. IX, p. vi.*]

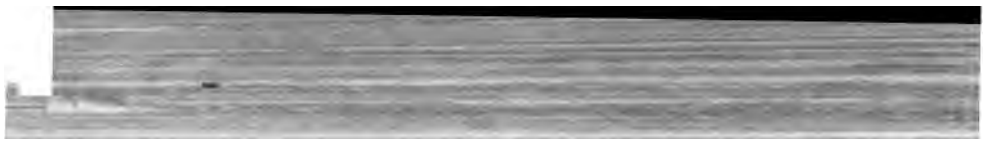
Resolved, That the secretary and treasurer be instructed to strike from the list of active members of the Academy the names of all who are in arrears in the payment of annual dues, except in those cases where, in their judgment, it is desirable to retain such members for a longer time.

ARREARS OF ANNUAL DUES.

[*By the Council, December 29, 1897.*]

Resolved, That the treasurer be requested to send out the notices of annual dues as soon as possible after each annual meeting and to extend the notice to the second or third time within a period of four months where required.

NOTE.—The Printing Commissioners of the State of Wisconsin now require all copy to be at hand ready for the printer before the permit for printing shall be issued by the Secretary of State. But, under a ruling of the Commissioners, made in response to a presentation by the Committee of the Academy appointed December 29, 1897, each volume of the Transactions may be issued in two consecutive parts; so that a publication may thus be issued each year covering the papers accepted after the previous annual meeting.



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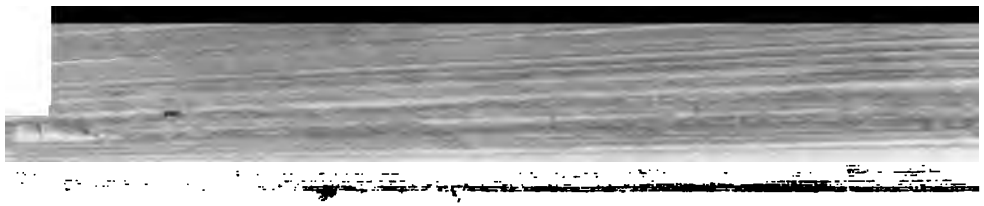

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